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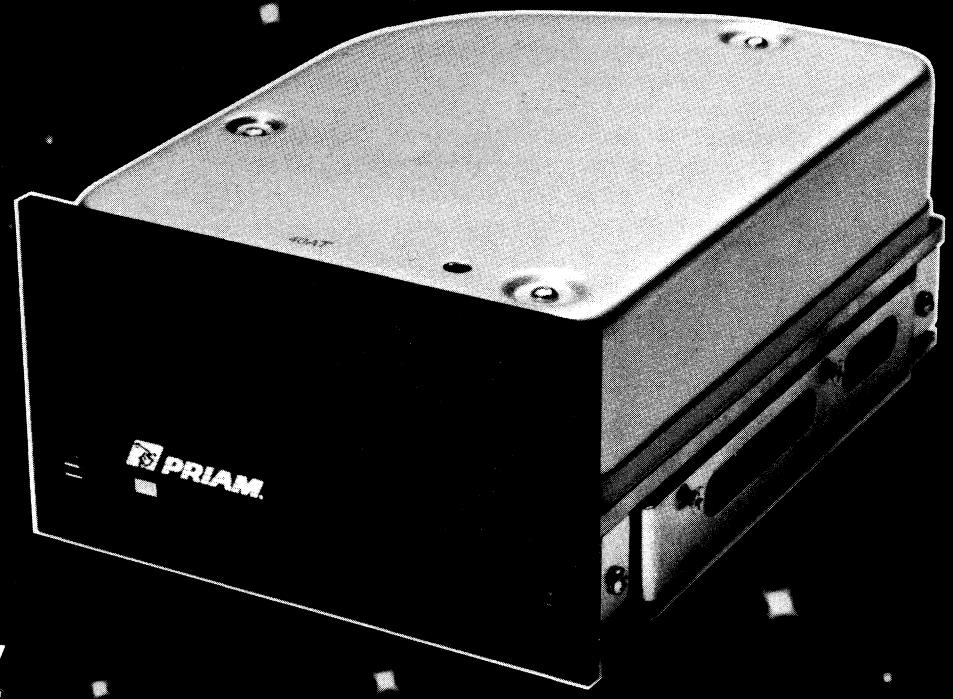

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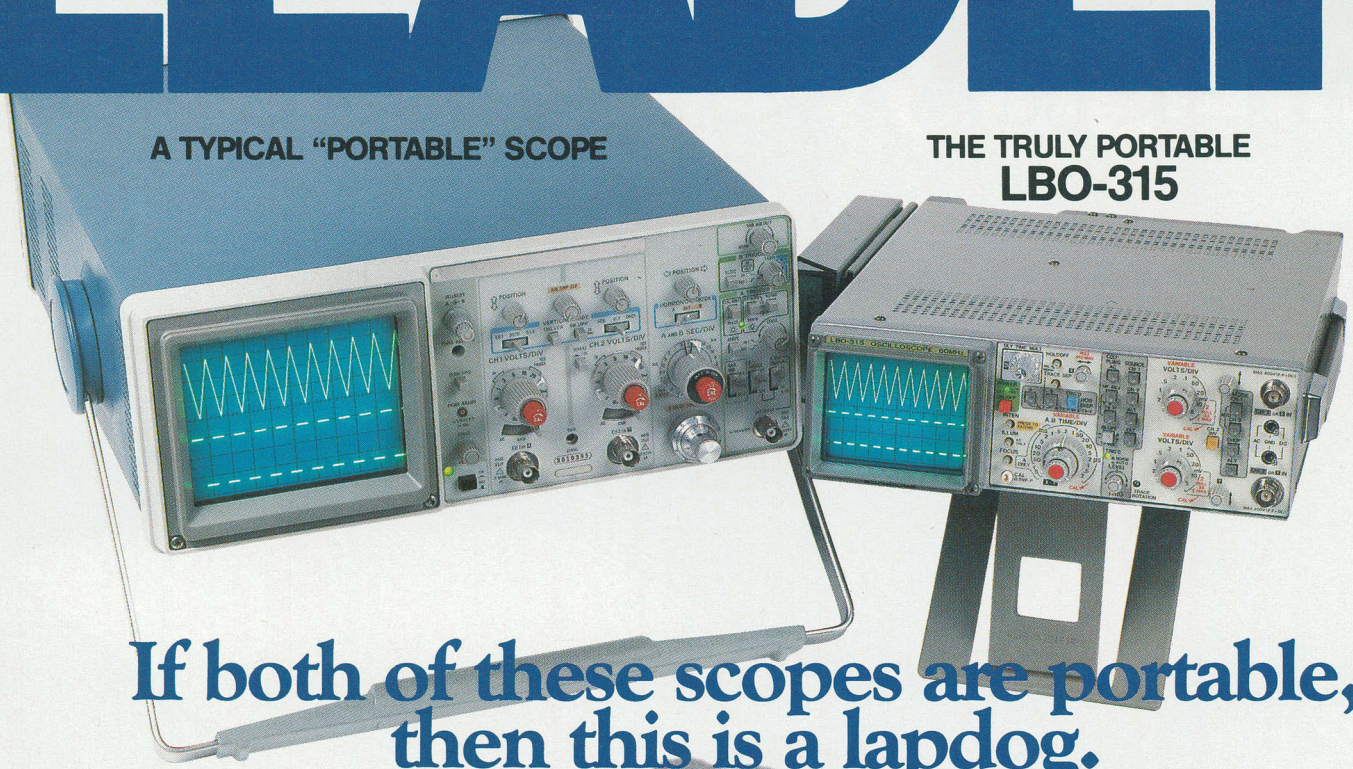

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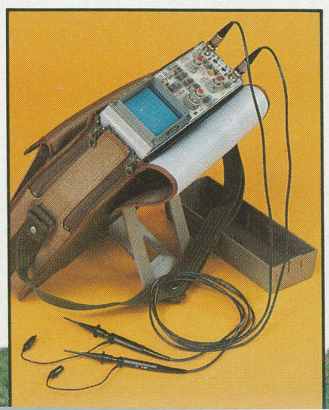

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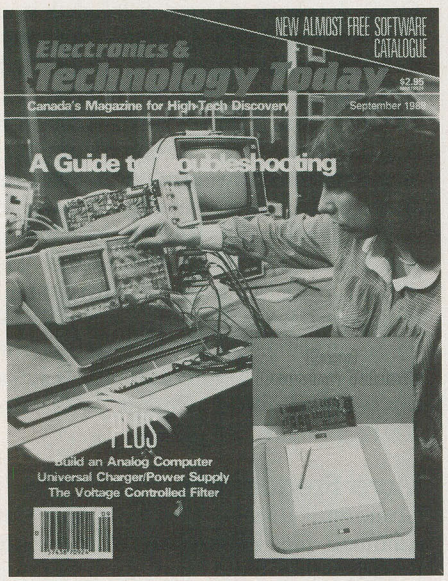
Electronics & Technology Today

Canada's Magazine for High-tech Discovery

Volume 12, Number 9 September 1988



Our Cover

The troubleshooting photo is courtesy of Tektronix Canada; the Easyl tablet was photographed by Bill Markwick.

FEATURES

TECHNOLOGY

PROJECTS

PRODUCT REVIEW

INFORMATION

Please Note

We value input from our readers, but we regret that the editorial department is unable to answer telephone queries.
If you have difficulties or suggestions, please write to us, enclosing a stamped self-addressed envelope, and we will answer you as soon as possible.

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FOR YOUR INFORMATION

Corrections

In our last month's review of the CAT Image Scanner, which turns your Epson into a 300 DPI scanner, we negligently omitted the address of the Canadian representative. It's available from Tricor Computing Ltd., 5035 Timberlea Blvd., Unit 6, Mississauga, Ontario L4W 2S3, (416) 238-0204.

We also regret that the 386 computer article promised for this issue was held up by editorial and production difficulties, including the rounding up of suitable computers to put through their paces. We hope to have it all togther for an upcoming issue soon.

X-ray Chip Fabrication

The IBM Research Division of NY has announced the use of X-rays to produce microchips by the lithography method. An electron storage ring generates the X-rays, which pass through a lithography mask to expose the silicon wafer. The result is 0.5 micron line widths of exceptional precision, and experimental techniques have produced line widths as low as 0.25 micron. The project demonstrates the feasibility of the X-ray method for production work.

Specs on disk

Motorola's Specs in Secs is an MS-DOS database on one 5.25" disk containing 58 product categories with technical information on over 7,200 devices, 20,000 cross-references and 130,000 parameters. You can search by part number or by various parameters. Our sample copy dazzled us with the speed at which it operates: your finger barely leaves the Return key before you have a list of what you want. The disk is available from Motorola Semiconductor Sales Offices, or for $2 US by requesting DK101/D REV 1 from the Motorola Semiconductor Literature Distribution Center, PO Box 20912, Phoenix, AZ 85036.

More Frequencies

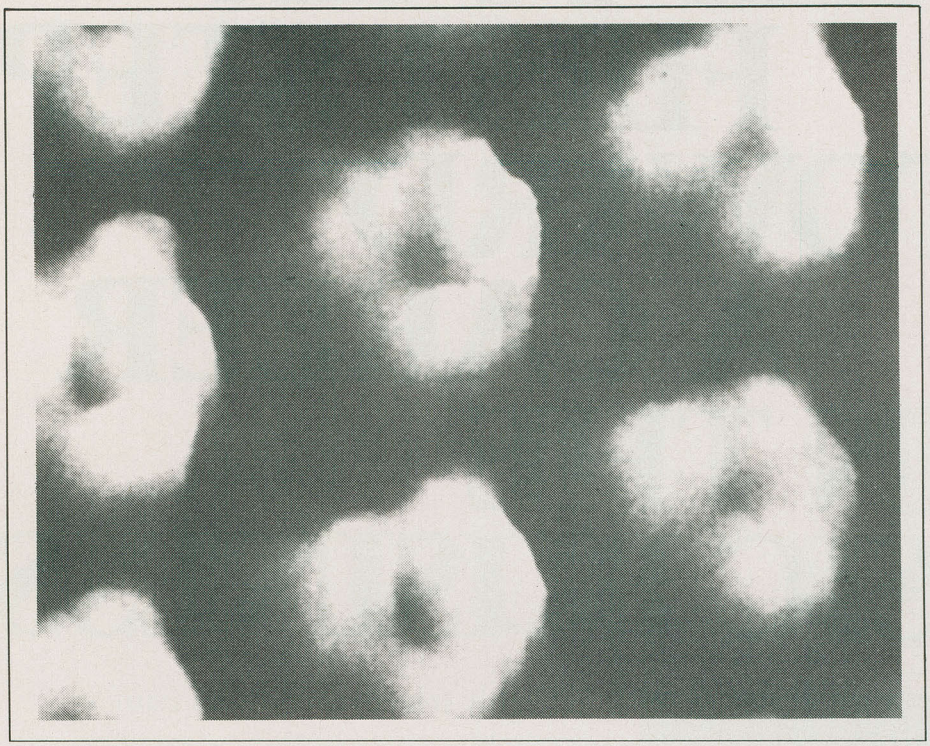
Communications Canada has announced an expansion of the AM broadcasting band, with an additional ten frequencies being added from 1605 to 1705 kilohertz. The new frequencies will provide relief to frequency-congested areas and offer long-term opportunity for expansion in other areas. New radio stations could be operating within two years. There was no discussion of the fact that most commercial AM radios do not go above 1600kHz.

Jobs Increase

The Technical Service Council of Toronto reports that jobs for engineers, scientists, executives and other professionals increased 32% in the year ending June 30. Over 50% of the reported vacancies were in Ontario, with the overheated Ontario market producing both shortages and surpluses.

Pet Peeve

Yer Humble Editor has just finished putting electrical outlets in a basement room, and as usual, is amazed, boggled and appalled by the quality of the North American electrical system for domestic applications — tinny little boxes with sockets that don't fit, rickety lighting fixtures, absurd rules, etc. The word "crap" comes to mind frequently. I can't be alone here. Maybe it's time for a full- length article on this.



An image of benzene molecules produced with the scanning tunneling microscope.

First Molecule Photos

Scientists at IBM's Almaden Research Center have produced the first pictures that show how atoms are arranged in individual benzene molecules. Arranged like ranks of freshly made doughnuts, the molecules clearly show the ring shape familiar to generations of organic chemistry students around the world.

The pictures were generated by a Scanning Tunneling Microscope (STM), an instrument invented by two IBM researchers who shared the 1986 Nobel prize in physics for their work. The images reveal the internal structure of each molecule attached to the surface of rhodium metal.

The picture helps confirms the theory of August Kekule, who in 1865 proposed that benzene's atoms form a ring (the famous story about this says that Kekule had a dream of a snake eating its tail).

The benzene ring images were produced by Hiroko Ohtani of IBM Japan, Ltd., amd Robert J. Wilson, Shirley Chiang and C. Matthew Mate of the Almaden Research Center.

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This year, over $1.5 *billion* worth of digital electronic music instruments—keyboards, guitars, drum machines, and related equipment—will be sold in the U.S. alone. Who's buying this new-tech equipment? Not just progressive musicians and professional recording technicians, but also thousands of people who have never touched a musical instrument before. And there's good reason why.

Something called MIDI (Musical Instrument Digital Interface) has suddenly transformed musical instruments into the ultimate computer peripherals . . . and opened up a whole new world of opportunity for the person who knows how to use, program, and service this extraordinary new digital equipment.

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Dynamic New Technology Opens Up New Career Opportunities for You

The opportunities are unlimited for the person who's trained to take advantage of today's electronic music phenomenon. Now you can prepare for a high-paying career as a studio technician, sound engineer, recording engineer, or road technician . . . even start your own new-age business providing one-stop sales and service for musicians, technicians, and general consumers alike. Or simply unleash your own musical creativity with the breakthrough training and equipment only NRI gives you.

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The Casio CZ101 digital synthesizer, also included in your training, is the perfect complement to your Atari ST. The polyphonic, multitimbral CZ101—which stores up to 32 voices internally—"communicates" with your ST computer through MIDI, bringing life to virtually any sound you can imagine.

Plus, you get ingeniously designed MIDI software that opens up amazing new creative and technical possibilities . . . you actually build your own 4-input audio mixer/amplifier . . . and you test the electronic circuits at the core of today's new-tech equipment with the hand-held digital multimeter included in your course.

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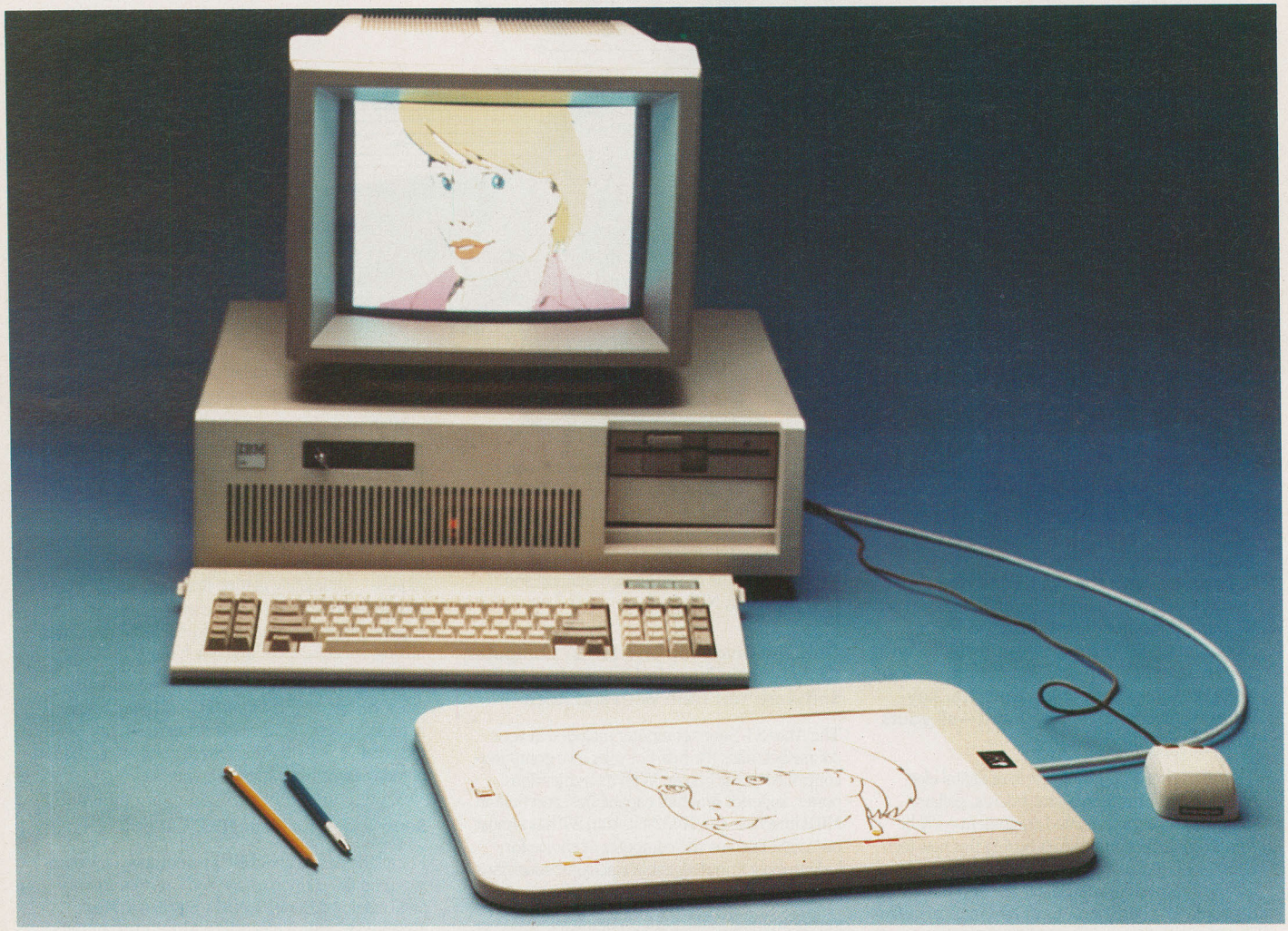
Easyl Drawing Tablet

A worthwhile graphics alternative to the mouse for PC and Amiga computers

BILL MARKWICK



The first time you use a paint program or a computer- aided drafting program, you find out that the main difficulty is communicating your graphic ideas into a machine designed for number-crunching and text entry. The keyboard, while workable, is painfully restrictive and is generally used only for making small adjustments to the cursor. The mouse, everyone's general-purpose favourite, is much better at dealing with lines and curves, but it requires quite different muscular movements than you would use to manipulate a pencil or brush. Digitizers are the same; they use a mouse with crosshairs and are generally in an absolute mode (each point on the digitizing pad always corresponds to the same spot on the screen, as opposed to the relative mode of the average mouse, which can be picked up and set down anywhere without moving the cursor).

One way to get the best advantages of the mouse while retaining the sensitivity of the pencil is the Easyl Drawing Tablet from Anakin Research of Rexdale, Ontario. It's a flat plastic pad with a drawing area designed to hold an 8 1/2 by 11 sheet of paper; also in the package is the software, circuit card for the IBM PC/XT/AT and compatibles, with another version available for the Commodore Amiga 500/1000/2000.

To work the pad, all you have to do is place a piece of paper on the surface and start drawing with a pencil, pen, or even a blank stylus. Your pencil strokes will appear in whatever graphics program you're using; you get all the functions you would with the usual mouse, plus the familiarity of the stylus mode.

Installation

The Easyl uses an unique approach to integrate itself with the computer: instead of taking over one of I/O ports, as do most peripherals, the Easyl uses its own 9-

pin D-connector for the pad, and the computer's serial port COM1 now appears on the Easyl circuit card's 25-pin D-connector (or COM2, if you prefer). Just why they move COM1 or COM2 from your connector to yours will become clear as you begin to find out the many features of the Easyl: for one thing, the COM port is returned to normal service if you're not using the pad, and for another, you can have a mouse running at the same time as the Easyl.

The circuit card is easily fitted, but due to the port swapping described above, you'll have to disable your computer's COM1 (or COM2, whichever you're using). Sometimes this is easy, involving only a jumper move. With some computers, you may have to see your dealer to find out how to unhook your serial port. Once this is done, your new COM port is ready to accept various rodents, including the Microsoft Mouse, Logitech Mouse, PC Mouse, Summamouse and ITAC Trackball.

The pad itself is hooked into its own D-connector, and you're ready to install the software. If you have a hard disk, all the various drivers can be copied over in case you need them; otherwise you can copy the relevant driver onto your boot disk. Incidentally, the software includes a batch file called INSTALL, which helps you along in the process. Unfortunately, so do most other gadgets for the PC, leaving you with INSTALL (or SETUP) files all over your hard disk (or worse, overwriting each other).

Configuring

If you don't plan to use your Easyl all that much, you may be worried about the tinkering with your COM port if it's normally used for something else. The software includes a file called ELOAD, which configures your new COM port as a regular serial port; we didn't find any problem at all with software or hardware that previously used the computer's serial port.

The many drivers in the ECONFIG file allow the pad to be configured as a Bit Pad One, or a Summagraphics MM961 digitizing tablet, or as a drawing tablet for GEM software (both new and old versions), PC PaintBrush, Dr Halo and AutoCAD. We tried it with Ventura (runs under GEM), Dr Halo, Microsoft Windows and AutoCAD, and all the drivers hooked everything up nicely.

The menu-driven ECONFIG file can be run anytime that you want to change something; it's comprehensive and easy to use. You can even modify such things as mouse speed. The manual contains a fair amount of information for running the Easyl with programs that aren't listed in the menu.

The Command Strip

Along the bottom of the drawing area is a touch-sensitive strip with 15 predefined functions. These are used to change parameters on the fly, saving you the bother of exiting and re-running ECONFIG. Some of the things you can change include sensitivity (number of points sent to the computer – this affects drawing speed, from fine to "sketch"), mouse speed, return to normal serial mode, save current parameters, and more.

Under the command strip are two buttons, the equivalent of the buttons on a mouse. The command strip will configure these as either normally-closed or normally-open.

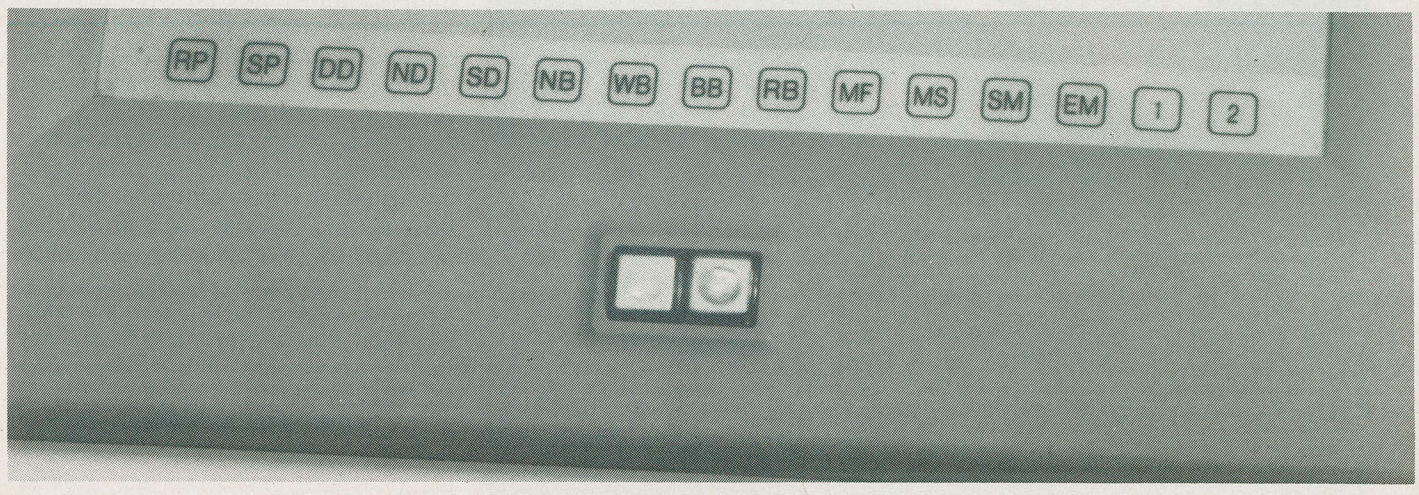
There are also registration pegs included that will hold 3-hole punched paper, and some sample strips of a special double-sided tape, 3M #9415, which has a strong adhesive on one side and a reusable milder adhesive on the other, letting you repeatedly stick your paper to the Easyl.

Using It

The Easyl method of drawing may not be for everyone; if you want one general-purpose pointing device for everything, a standard mouse might be better. However, if you do any sort of computer graphics or drafting, the stylus method feels very natural, much more so than a mouse, and your accuracy will improve quite a bit. It's a pleasure to draw with the familiar pencil method.

The Easyl may not be what you want with AutoCAD; to move the cursor around, it's necessary to press down on the pad while moving the stylus, something that feels awkward compared to sliding a mouse or moving the magnetic puck of an absolute-mode digitizer. Desktop publishing programs such as Ventura and Pagemaker were fine with the Easyl.

With paint programs, however, the Easyl shines. It's probably the best system so far for the interface between paint programs and the artist. With registration pins for animation work, the Easyl is used widely for broadcast graphics. The Easyl has a suggested retail list price of $699, and is available from various computer dealers. If you can't find one in your area, contact the manufacturer, Anakin Research, 100 Westmore Drive, Unit 11C, Rexdale, Ontario M9V 5C3, (416) 744-4246. ■



The Easyl pad has a touch-sensitive strip just above the switches that serve the functions of mouse buttons. This strip allows control of mouse speed, pushbutton configuration, drawing speed and more.

Controlling Pollution With AI

Artificial intelligence is ideal for the monitoring of chemical spill detectors.

K. TAHIR SHAH

On April 19, 1986, four explosions at downtown Saint John shook not only nearby buildings but also government and industry officials. The explosions were the result of a gasoline leakage from an underground tank into the city's sewer system. Two similar cases, one at Timmins and the other at Oakville, both in Ontario, occurred the same year. There are an estimated 200,000 underground tanks storing hazardous chemicals in Canada. There is no doubt that any one of them can lead to a Saint John type accident.

An estimated six million Canadians depend on ground water as their source of drinking water. A single litre of gasoline can make about ten million liters of water unfit for human consumption. Underground water is a slow moving fluid and it remains in a contaminated state for a long time. Eventually, it can also contaminate our rivers and lakes by slowly adding hazardous chemicals to those already existing.

According to a recent Environment Canada report (State of the Environment Report for Canada, May 1986), there is no systematic national monitoring program to measure the contaminants in drinking water. Drinking water quality is regarded as a municipal and provincial responsibility. In the past, there was little evidence that drinking water might constitute an important source of exposure to toxic compounds. The pollution awareness is a recent phenomenon.

One Million Tanks

In the US, the situation is more complex due to its large industrial base and the concentration of industry in some states. It is difficult to estimate an exact number of underground tanks all over the US. However, according to the US Environmental Protection Agency (US-EPA) estimate, there are about a million such tanks in urban and industrial areas. Another unspecified number is located in farms. All but 50,000 or so contain petroleum products. Moreover, 85% of these existing tanks are constructed from unprotected steel and they are single walled. In the 1950s, with the increasing use of the automobile, the number of tanks increased dramatically. Neither was any public awareness of environmental problem nor was there any government initiative to that end. The median age of underground tanks is about 17 years, according to an EPA study. This fact confirms the above observation. There were no fiberglass or double walled tanks in those

days. An obvious consequence is that now there are too many leaking tanks.

In November of 1984, the US president signed an act now referred to as the "Federal Tank Law" which, among other things, calls for the federal EPA to establish permanent standards in respect to underground tanks. One important aspect of an EPA mandate is to recommend some sort of high precision and acceptable monitoring methods for these tanks. A plain stick will no longer be sufficient to control inventory and detect any loss of fluid. The first step was to study carefully technical aspects of leak detection and define properly protocols for evaluating leak detection methods for underground storage tanks.

Leak Detection

In a 1986 research paper from the EPA's Hazardous Waste Engineering Laboratory, Edison, NJ, titled: "Protocol for evaluating volumetric leak detection methods for underground storage tank", described an approach which would yield estimates of the smallest leak rate that each (commercial) method can reliably detect, together with estimates of their associated probabilities of false positive and false negative indications. A false positive is when there is no leak but due to other effects the device shows a leakage signal. A false negative is when there is leakage but it is masked due to noise effects. Tests of commercial volumetric leak detection devices using both the protocol and the test apparatus started in July 1986, at Edison, NJ. One strong reason for testing commercial systems is, according to this report, that the capabilities of available test methods are unknown. Claims of excellent performance are little supported, if at all, by theoretical or experimental evidence.

Although underground and above ground storage tanks have been in use for a long time, only recently did they become the focus of attention by private and public agencies responsible for environmental pollution control. The problem created by the leakage of hazardous materials began affect the quality of our living environment. The leak detection devices and underground pollution control were the major themes at CONVEX 86, the 1986 convention of the Petroleum Equipment Institute (PEI) at Baltimore, Maryland. Again, in October 1987, underground pollution was a major theme in a similar PEI's convention held at Toronto.

A recent study by the US Environmental Protection Agency (Report No. EPA/600/M-86/020, August 1986) gives some dimensions of this problem with reference to hydrocarbons in underground tanks. The statistics are based on a total of 12,444 reported incidents. The reported release incidents included in the EPA data base are believed to represent only a fraction of total number of tank releases which cannot be accurately estimated from the EPA data base. Some highlights of the documented release data is as follows:

- From 1970 to 1984, there was a continuous increase in the number of releases annually.
- A higher release frequency in states where there are more corrosive soils.
- About 95% were releases from operating facilities. Only 5% were attributed to abandoned facilities.
- Retail gasoline stations were major culprits with 65% of the incidents.
- 17 year mean and median tank age.
- Only 3% release of chemicals other than petroleum fuels.
- Between 43% to 58% of releases were to surrounding soil.
- Only 10% of storage facilities used some detection methods; out of this, 14% used inventory control methods.
- Overall gasoline accounts for more than 70% of the reported release incidents.

What this statistics suggests is that there are many more leaking tanks that need the serious attention of those who are responsible for regulatory control. I do not expect any radical difference in the statistics on this side of the border.

Because of the large number of underground tanks and the cumulative effect of even small leakages, the ability to monitor and detect leaks is essential to underground pollution control. In response to leakage and environmental contamination problems, the US Congress passed a law regulating underground tanks containing petroleum products and other hazardous chemicals. During 1987 the US-EPA is to propose standards for all new and existing tanks as well as regulations for leak detection, prevention and corrective action. Final standards and regulations will be issued in 1988 after a period of public comment. However, the US National Fire Protection Association, and informally EPA, have indicated that a precision tank test method should detect a leak rate as small as 0.05 gal/hour (0.2 lit/hour) while simultaneously employing some type of compensation for thermal expansion of the fluid hydrocarbons. Under the so called "Interim Prohibition", all storage tanks are required to provide some kind of system to prevent leakage. According to TulsaLetter, a newsletter published by the Petroleum Equipment Institute, leak detection and monitoring systems will become mandatory as soon as standards are defined formally.

A leak detection method must be of sufficiently high precision and accuracy in order to distinguish a leaking from a non-leaking tank. Let me elaborate.

There are four general classes of leak detection methods:

Volumetric: This is a quantitative method for leak detection and the leak rate measurement. The basic entity measured is volume or change in volume of the fluid.

Nonvolumetric: This class of techniques determines a leakage qualitatively.

Inventory control: In this class of methods the total fluid input and output is calculated. Accuracy depends on the device or techniques used for inventory control.

Leak effects monitoring: Leaks are detected or identified by monitoring the environmental effects.

Variables

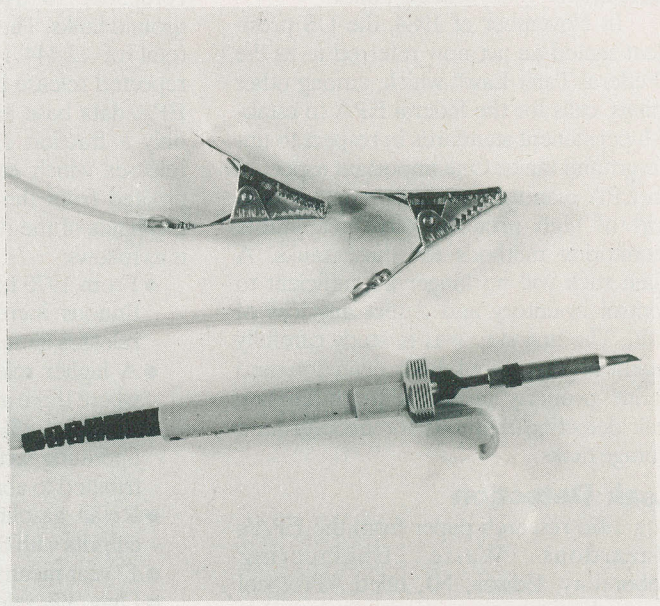
Most experts would agree that volumetric methods are perhaps best for detecting a very small leakage. In a continuous monitoring situation where the volumetric method is employed for leak detection, the inventory control is also possible with improved accuracy.

As I have mentioned above EPA may set 0.5 gal/hour leak detection threshold as standard. To understand why this is not a standard already, leads us into the technical aspects of design and the physics and engineering of such devices. The complexity of such high resolution detection and its technical and economic feasibility can be illustrated by the following fact. The number of variables involved, i.e., principal variables which effect the accuracy of most of the detection methods is very large.

These factors are:

Temperature change
Water table
Tank deformation
Vapour pockets
Product evaporation
Piping leaks
Tank geometry
Wind
Vibration
Noise
Equipment accuracy

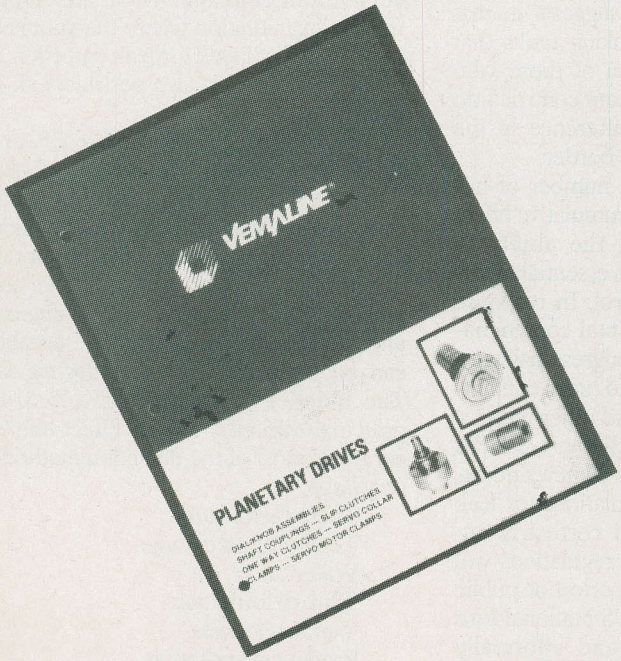
NEW PRODUCTS



Battery Soldering Iron

A new soldering iron has been inroduced that works directly from any 12V battery, making it ideal in auto or marine applications. The 25W element projects under the slip-on tips and a handle-hook is provided. Cobra Sales.

Circle No. 7 on Reader Service Card



Planetary Drives

Not the kind that can hit Warp Factor Five, but the ones that control dials and potentiometers in various electronic packaging. A catalog of drives, dial/knobs, couplings, clutches, etc., is available from the Weiss Company of Mississauga.

Circle No. 8 on Reader Service Card

Intelligent Multimeter

The Model 4070 performa automatic measurements and has an automatic timer, data calculation, programmed math, data store, 4-channel DMM, GPIB function and more. Brunelle Instruments

Circle No. 9 on Reader Service Card

WIN AT THE AD GAME

toronto business magazine

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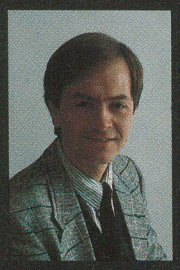
If you interact with media reps, printers, film houses, or typesetters, then this dynamic, four hour, evening seminar is designed for you. Learn how to: analyze strategies; isolate your unique selling points; target your audience; select media; work with film and pantone colours; pick typestyles; and more. Understand the five elements of a print ad. Know the basics of creating effective, consistent support material.

Seminar Leader

Robert Cohen, author of the "The Ad Game . . . Recreating Creativity To Sell", has a BBA and an MBA and has completed two years of Doctoral work in strategic marketing. He is President/CEO of The Cohen Group Inc., Marketing, Advertising, Public Relations. Mr. Cohen was a Professor at Trent University and in York University's MBA program.



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Operator error
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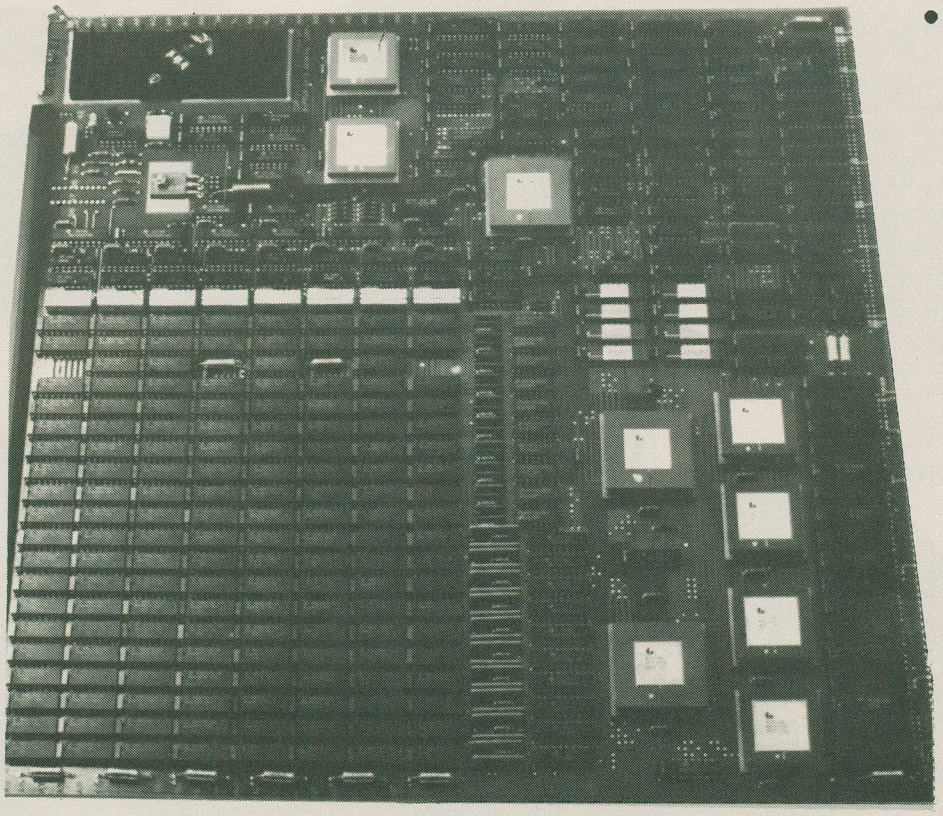
Power variation
Instrumentation limitation
Atmospheric pressure
Tank inclination.

The most important effect is thermal expansion which is usually straightforward to measure. However, at 0.05 gal/hr leak detection resolution, the thermal effects can easily mask or enhance leakage. For instance, in a typical case of a standard 8,000-gallon tank, a change of one tenth of a degree centigrade of temperature can cause a change in volume which is more than the quantity of fluid leaked in an hour. In other words, high precision is also required in temperature measurement to calculate thermal compensation or else one may get false results. This problem is referred to as signal (actual leakage) to noise (effects due to variables listed above) separation problem. Other factors such as tank geometry or evaporation are not measurable as accurately as thermal expansion or the change of total volume. The problem at hand is very complex, and only microprocessor based systems are capable to taking into account many factors simultaneously. At present, there are only two European made devices with claims that they can detect 0.05 gal/hr leak. Otherwise, there are no well tested continuous monitoring and leak detection systems with such high resolution.



The increasing power of the microchip makes possible the processing and coordination of the great amounts of information from sensors. In addition, expert systems using AI can make decisions regarding courses of action.

Enter AI

To solve complex problems of this sort where conventional techniques, whether engineering or computational, have failed, researchers are beginning to use artificial intelligence. For instance, in the past five years many expert systems for real time applications were built and now are available commercially.

What is an expert system? The expert systems are intelligent systems having knowledge about some narrow domain stored in their knowledge base along with an inference mechanism. An expert system in a real time situation is typically used for intelligent interpretation of sensor data, diagnosis of problems, coping with process disturbances, prediction of consequences of actions, and economic optimization. It differs with other conventional systems in its flexibility and that it can detect problems which may not be explicit. In its knowledge base the casual relationships, besides empirical data, can be stored which may either by physical laws and other qualitative/heuristic knowledge about the system, or a mixture of the two. The real time data from the sensors, for example, can be manipulated using the knowledge about the physics of the system to achieve some desirable solution in a manner a human expert would do. In other real time applications such as process control, the condition, which indicates a significant event, is a combination of process measurements (i.e., sensor data) and process dynamic behavior dictated by the laws of physics. A typical example of the dynamic behavior would be the simple rate of change of some quantity such as volume of the fluid. In general, an expert system receives from a real time processor the following information:

- Current values of measurements, state estimates or other calculation.
- Indicators of possibly significant events such as alarm condition etc.

This information is then used to infer facts which are not in the knowledge base. Intelligent programs which are capable of inference are usually written in artificial intelligence languages like Lisp or Prolog.

Some large expert systems in complex applications use a focusing mechanism. For example, in a refinery or nuclear reactor or large complex of underground tanks, the monitoring system focuses its attention to some specific part if a problem is noted there. An expert system with a "Focusing" mechanism thus can invoke logic rules and procedures when they are required for some specific purpose or requested for a specific step in the procedure. This mechanism is sometimes called "inference directed data retrieval". Once the required data is retrieved, it can be used for whatever reason it was requested.

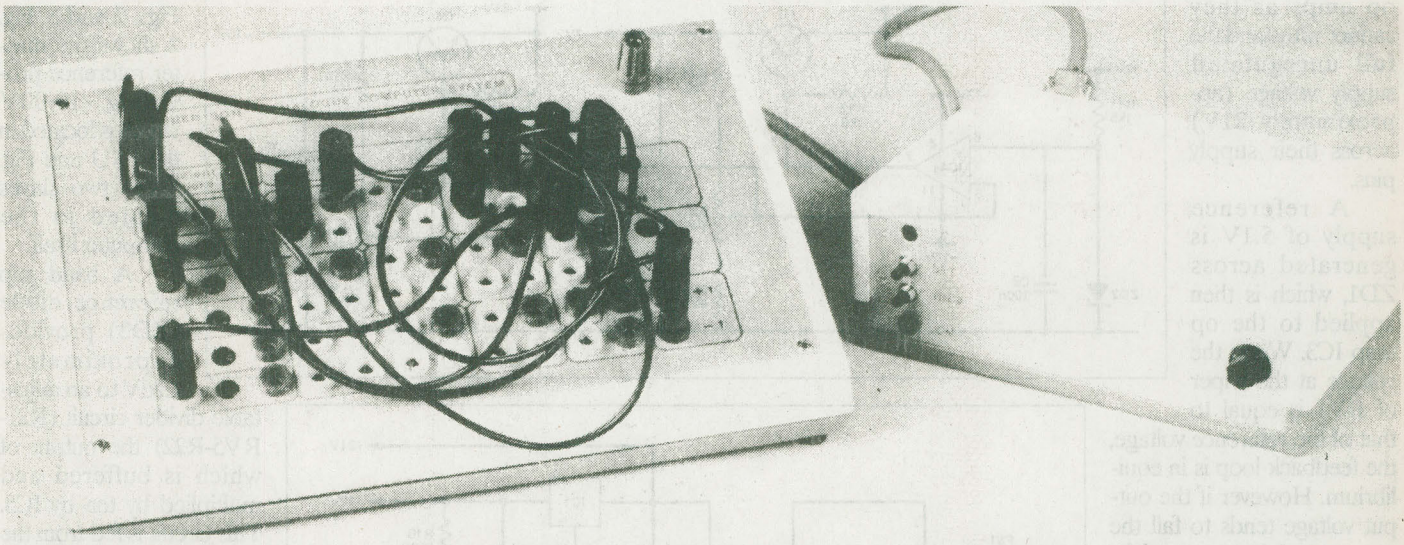
The science of artificial intelligence can be valuable to solve many difficult and so far untouched problems of pollution control whether underground or above ground. I have no doubt that with the help of computer aided intelligent pollution control devices we shall be able to keep our environment safe and clean. ■

PROJECT

Build an Analog Computer

The first part of a project for a small simple-to-build analog computer circuit for education or experiment.

PAUL CUTHBERTSON



Many of the early analog computers were true monsters, requiring four strong persons to lift them, and then with some difficulty. Fortunately, modern integrated circuits have come to the rescue and we can build a sensible small computer which, although no match for the performance standards and facilities of the bigger ones, represents considerable saving in weight, cost and power consumption.

This computer provides eight summing amplifiers, six coefficient multipliers and four integrators with over and under voltage indication. It is housed in two boxes – the power supply and the computer itself – with a cable connecting the two. The PSU can power a number of other units if the user wishes to install extra connectors for this.

There are controls for SET and HOLD on the power supply. The front panel of the computer is rather more complex. There is an overvoltage indicator, the four integrators, eight summing amplifiers, six coefficient multipliers and outlets for the +/-10V references.

Such a small system is useful in a school or university laboratory or anywhere that experiments are done on control systems and such.

Mathematicians might like to note that in its present form the computer will solve linear differential equations, but not those which involve a function of two variables. Nor does it provide exponentiation or sinusoidal functions. However, the equipment to do this can be easily designed and if there is sufficient call for it, perhaps a future article may be devoted to such a unit. Even in its present form the system can be usefully employed in a number of ways in the lab.

Construction

Start assembly with the PSU. Mount all the PCB components first. Figure 4(a) shows the component overlay for the PSU board.

If a PCB-mounting transformer is difficult to obtain, a chassis- mount can be used, with wire links running to the appropriate points on the board.

Now solder the smaller components in place, making sure metal film resistors are fitted in the right places. Lastly, fit the transformer and mount the power transistors on their heatsinks. The transistors should be fixed to the heatsinks before inserting and soldering to the board. No insulator is needed.

Mount the board into the case with the transformer to the rear and drill the four fixing holes in the case base in line with the mounting holes in the PCB. Drill a hole for the mains cable, fit a grommet and solder the neutral and ground wires directly to the board with the 100mA fuse in line with the live connection.

Bolt the board to the case and after drilling holes and mounting the two switches (SET and HOLD), the LED and the power D- connector, wire them to the board as shown in Fig. 5. The connector blocks are not essential and the wiring can be made directly to the PCB, but removable connectors enable the board to be easily taken from the case for repair or alteration.

The PSU

The power supply provides +/-7V and +/-15V for any computer unit to use as well as the SET and HOLD signals.

The circuits for positive and negative halves of the PSU are practically identical and are shown in Fig. 1.

Preregulators, IC1,2 give +/-12V to power the PSU op amps as they cannot withstand the full unregulated supply voltage (approximately 21V) across their supply pins.

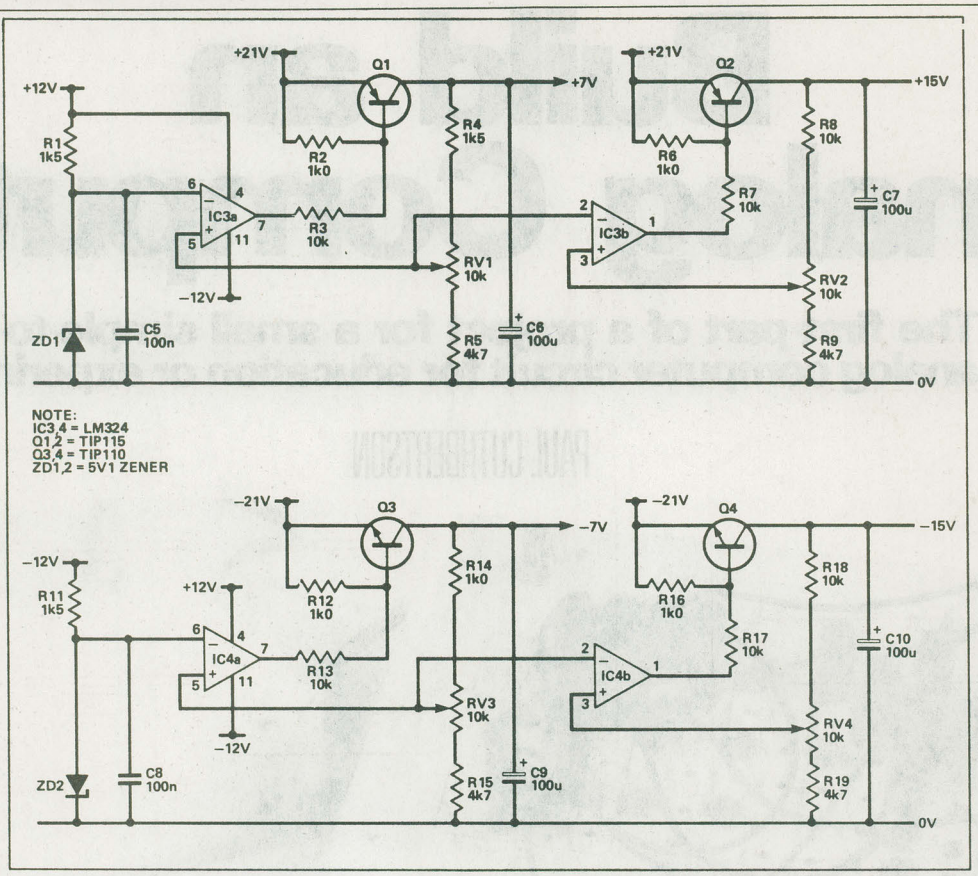
A reference supply of 5.1V is generated across ZD1, which is then applied to the op amp IC3. When the voltage at the wiper of RV1 is equal to that of the reference voltage, the feedback loop is in equilibrium. However if the output voltage tends to fall the op amp drives negative, causing more current to flow in the series pass transistor Q1 and thereby raising the output voltage. Similarly if the output voltage rises, the op amp output goes positive, cutting down the current flowing in the pass transistor.

Resistors R2,3 are chosen so the pass transistor is able to cut off when the op amp output is at or near the op amp supply voltage.

Very little current flows in the OV line. It isn't power supply line as such, but provides a 0V reference for signals. This results in quiet, stable operation.

A similar circuit derives the +/-15V supply. A special feature is that the 15V supply tracks the 7V supply. The 15V supply will not reach its full voltage if the 7V supply is pulled down or has failed for any reason. This protects the CMOS circuitry which uses the 7V supplies but which may be fed from circuits employing the 15V supplies. The tracking is accomplished by using the feedback signal from the 7V supply as the reference voltage for the 15V supply.

The performance of the supplies as regards load regulation and drift is quite exceptional.



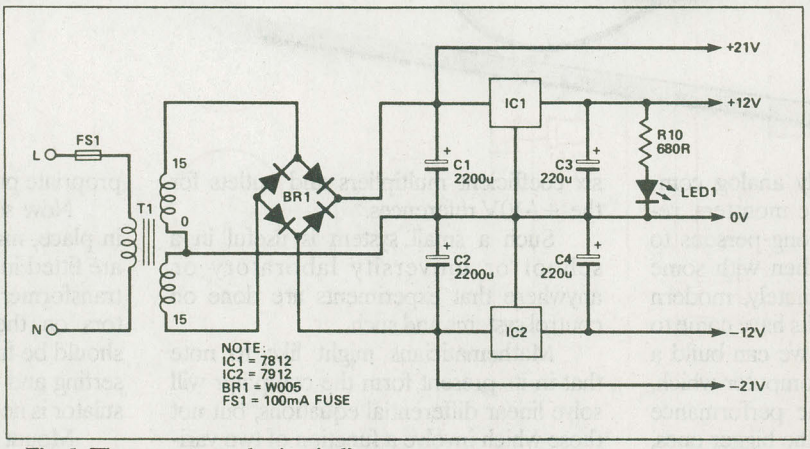


Fig. 1. The power supply circuit diagram.

The voltage reference are shown in Figs. 2 and 3. Fig. 2 shows the master reference providing -10.00V which is located in the PSU and Fig. 3 the two slaves located in the computer itself.

A band gap reference diode (ZD3) provides approximately 1.26V to an adjustable divider circuit (R21-RV5-R22) the output of which is buffered and multiplied by ten by IC5. This circuit is fed from the +12V and -15V supplies – if the -15V supply should fail then the master reference will be not provide possibly damaging voltages to other circuits.

Note that if the ZN423 or MP5010GN voltage reference diodes are not available, the required 1.2V can be obtained by substituting two silicon diodes (1N914, 1N4148, etc) in series (with the cathodes to the OV line). This is not a precision reference by any means, and will drift with temperature changes. However, it will allow circuit operation for experimenting.

The positive and negative slave references are an inverting and a non-inverting buffer respectively. Their gains are slightly adjustable (about 1% either side of unity) giving fine control over the reference voltage.

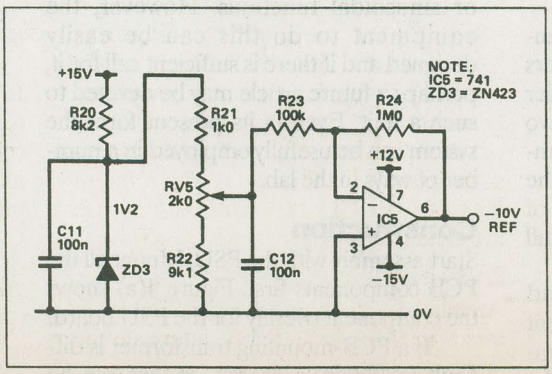


Fig. 2. The -10.00V reference source.

Multipliers

One of the coefficient multipliers is

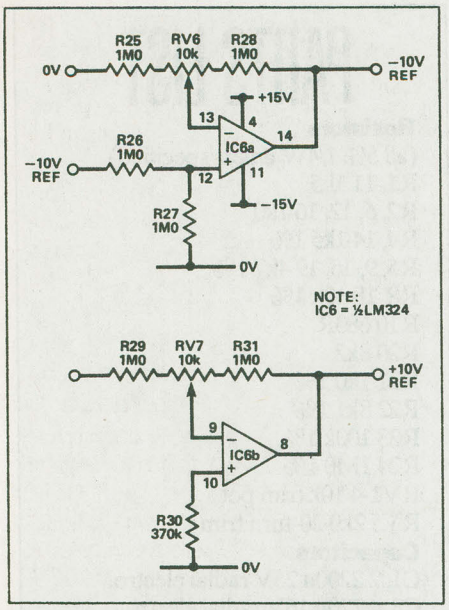


Fig. 3. The voltage reference buffers.

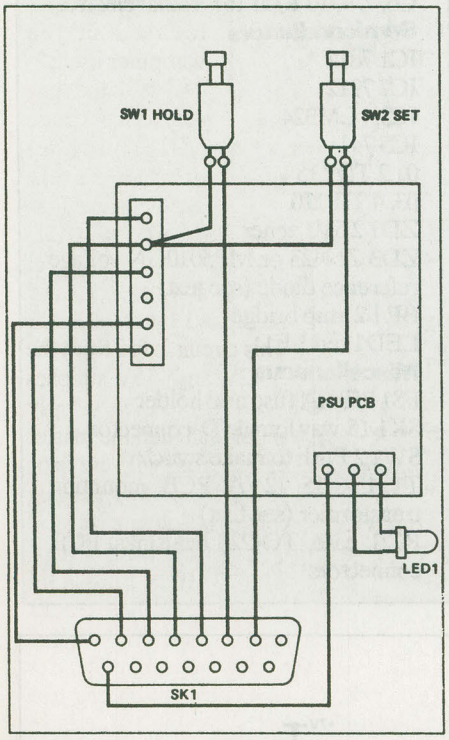


Fig. 4(b). Wiring the socket and switches.

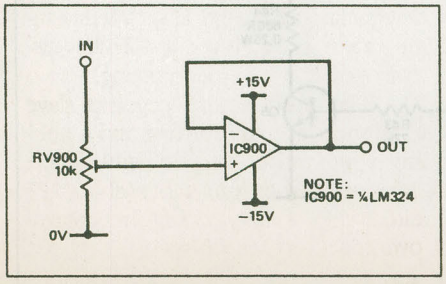


Fig. 5. The multiplier circuit.

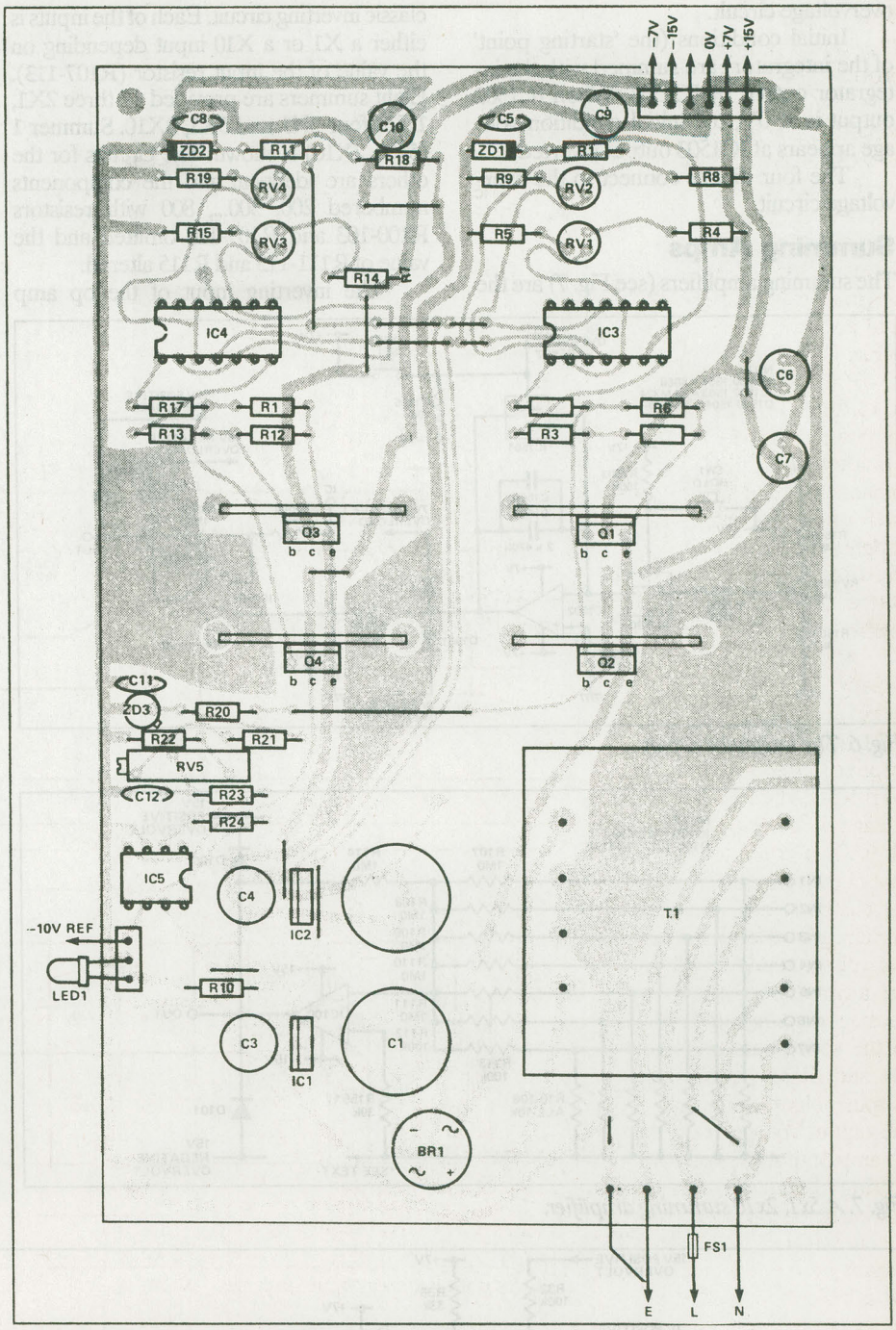


Fig. 4(a). The component overlay for the power supply.

shown in Fig. 5. These are simply potentiometers with a buffer amplifier on the output. The potentiometer is mounted on a small board at the front panel. The op amps are on the main board. The circuits for each are identical and numbered 900-1400.

Integrator

An integrator is shown in Fig. 6. The resistors R1500-RV1500- R1501 attenuate the incoming signal by a factor of two to render it safe for use in the analog switch, IC1500. RV1500 adjusts the time constant of the integrator. When the HOLD pushbutton is released, the analog switch IC1a is closed, allowing a current to flow in R1502, charging the parallel integrating capacitors C1500, 1501 and causing the output voltage of op amp IC1502 to ramp. Pressing HOLD opens IC1a and integration stops, regardless of the input voltage.

Pressing SET close IC1501, shorts the integrating capacitor and discharges it. The SET line also forces a reset of the

overvoltage circuit.

Initial conditions (the 'starting point' of the integrator) are summed with the integrator output by IC1503. When IC1502 output is at 0V, the initial condition voltage appears at IC1503 output inverted.

The four diodes connect to the overvoltage circuit.

Summing Amps

The summing amplifiers (see Fig. 7) are the classic inverting circuit. Each of the inputs is either a X1 or a X10 input depending on the value of the input resistor (R107-113). Eight summers are provided – three 2X1, 1X10 four 3X1 and 5X1, 2X10. Summer 1 (5X1, 2X10) is shown. The circuits for the others are identical and the components numbered 200, 300..., 800 with resistors R100-103 and R107-110 omitted and the value of R111-113 and R115 altered.

The inverting input of the op amp

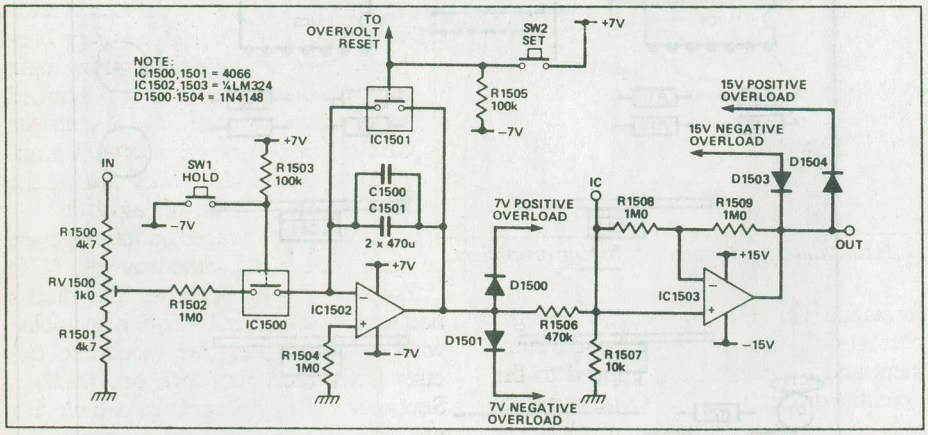


Fig. 6. The integrator circuit.

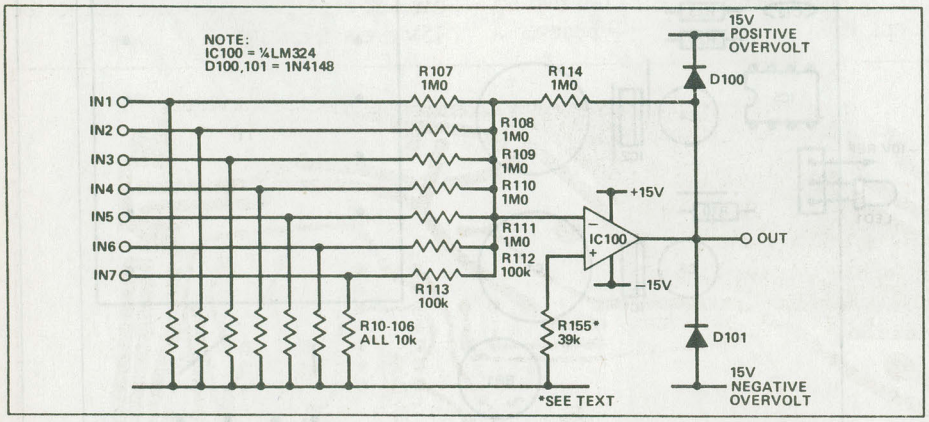


Fig. 7. A 5x1, 2x10 summing amplifier.

PARTS LIST

Resistors
(all 5% 1/4W unless specified)
R1, 11 1k5
R2, 6, 12, 16 1k0
R4, 14 1k5 1%
R5, 9, 15, 19 4k7 1%
R8, 18 10k 1%
R10 680R
R20 8k2
R21 1k0 1%
R22 8k1 1%
R23 100k 1%
R24 1M0 1%
RV1-4 10k trim pot
RV5 2k0 20-turn trim

Capacitors
C1, 2 2200u 25V radial electro.
C3, 4 220u 16V radial electro.
C5, 8, 11, 12 100n ceramic
C6, 7, 9, 10 100u 16V radial electro.

Semiconductors
IC1 7812
IC2 7912
IC3,4 LM324
IC5 741
01,2 TIP115
03, 4 TIP110
ZD1,2 5V1 zener
ZD3 ZN423 or MP5010GN voltage reference diode (see text)
BR1 2 amp bridge
LED1 red LED

Miscellaneous
FS1 250mA fuse and holder
SK1 15-way female D-connector
SW1,2 Push to make switch
T1 15-0-15 12VA PCB mounting transformer (see text)
PCB, case, TO-220 heatsinks, PCB connectors

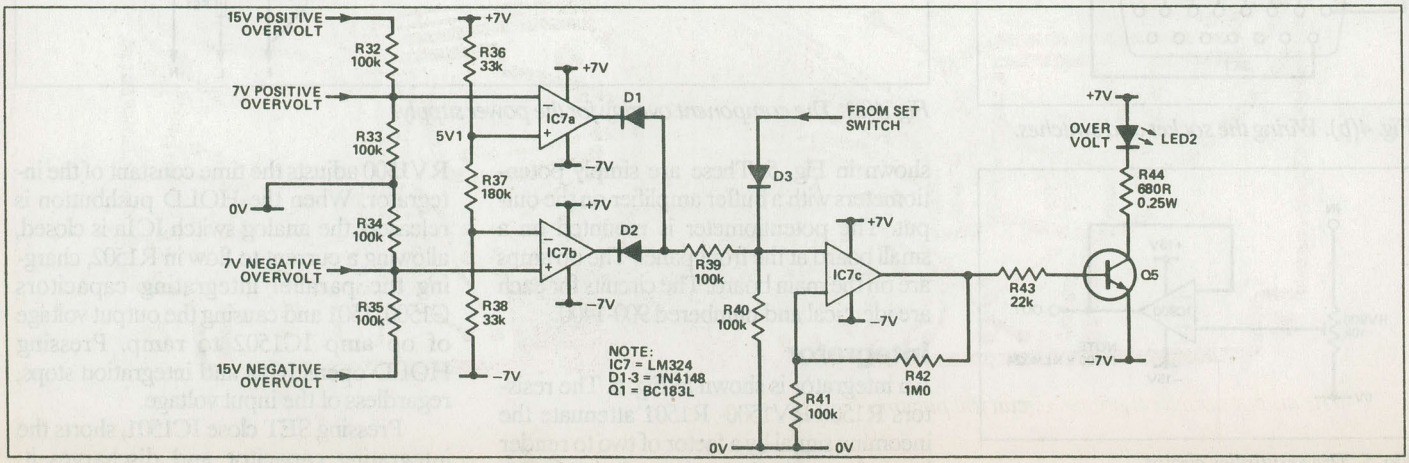


Fig. 8. The overvoltage warning circuit.

(C100) is maintained as a virtual ground point. The currents from all the inputs are summed at the inverting input of the op amp. The sum of these current flows in the feedback resistor (R114).

When inputs are unused, offset voltages due to bias currents might be a problem. These tiny currents need an external path to flow in. We need not tie unused inputs to 0V when using the computer, since the grounded 10K (resistors) R101-107) provide a path for the input bias currents to follow.

Looking at it another way, when an input is unplugged, the impedance seen by the op amp input does not change as much as it might, as there is a (relatively) small resistor shorting the other end of the input resistor to 0V. A similar technique is employed at the integrator inputs as well.

The resistor on the non-inverting input (R115) of any op amp is always chosen to be approximately equal to the parallel value of all the input resistors (R107-113). See Table 1 for a list of the values used in these circuits.

The two diodes D100, 102 route the output voltage to the overload detector. More on this later.

SUMMING AMP	INPUT RESISTORS 1MO	100k	R107 (207 . . .) VALUE
5×1, 2×10	Five	Two	39k
3×1	Three	—	330k
2×1, 1×10	Two	One	82k

Table 1. R107 values for different summing amplifiers.

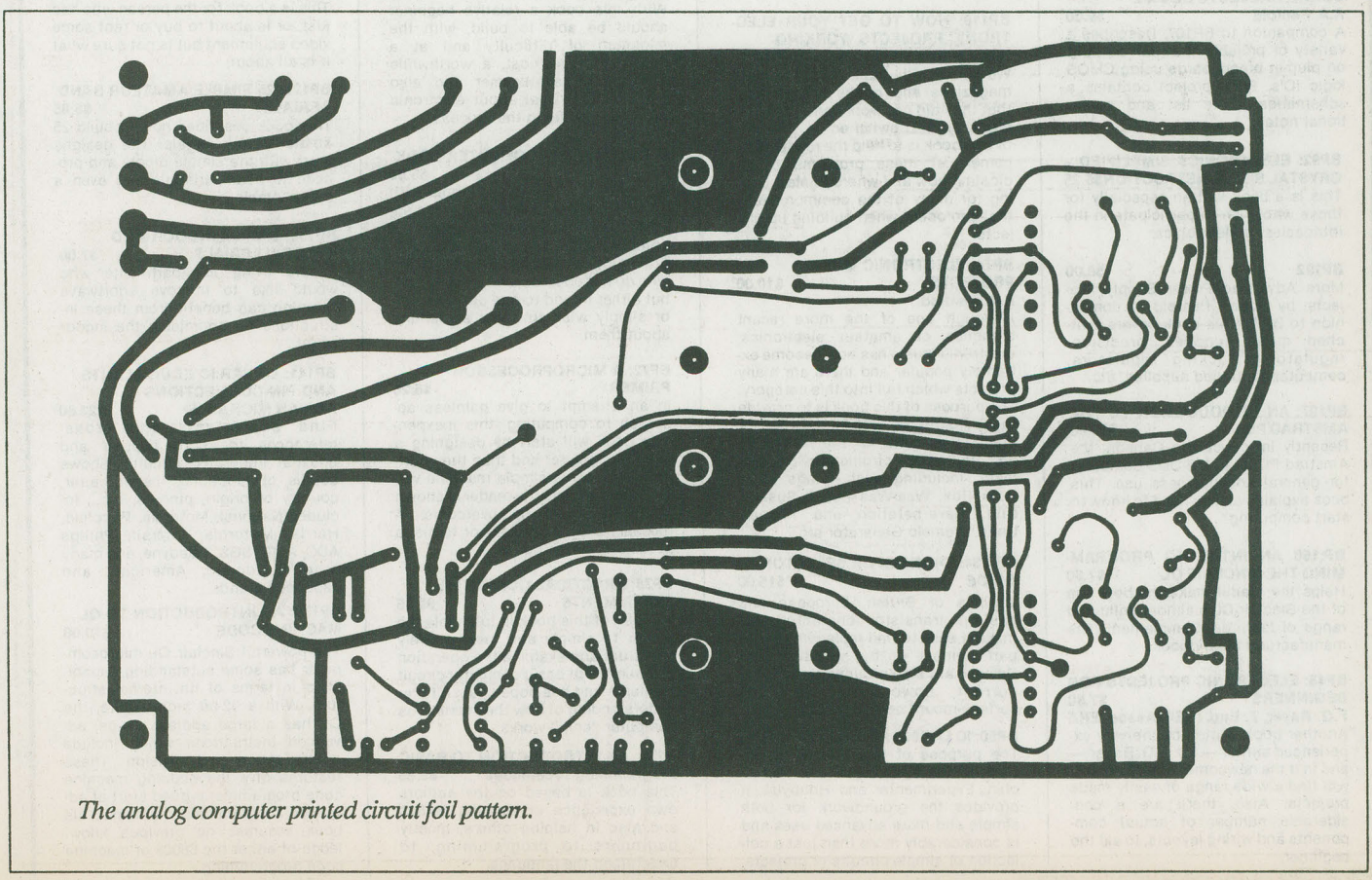
Overvoltage

The overvoltage circuit is shown in Fig. 8 and consists of a window comparator and a latch. The potential divider R36-38 develops approximately +5.1V at the non-inverting input IC7 and - 5.1V at the inverting input. Two rails carrying information about the maximum voltages present on any of the outputs of the summers and integrators, are applied to the potential divider R32, 33. A similar pair of rails concerned with minimum voltages is applied to the divider R34, 35.

Normally the outputs of the two op amps IC7a, b are positive. Whenever a voltage greater than about 10.2V plus one diode drop appears on the 15V overvolt rail or a voltage greater than about 5.1V plus one diode drop is applied to the 7V overvolt rail, the op amp IC7a will go negative, pulling down the inverting input of IC7c via D1 and R39. The output of IC7c will swing positive, turning on 05 and LED2.

Due to the hysteresis (positive feedback) applied by R41, 41, IC7c stays latched in the positive condition, even when the output of IC7a swings back positive. R40 ensures the inverting input of IC7c stays at 0V when not disturbed by an overvolt condition. Should the SET button now be pressed, +7V is applied to the anode of D3, causing the latch IC7c to be reset, turning off 05.

Negative voltages out of range are dealt with in the same way with IC7b output swinging negative. The diodes tied to the overvolt rails provide an analog wired-0R, preventing the monitored circuits from interfering with one another. Sections of the integrators which are powered from +/-7V (and cannot be expected to attain 10V) are tied to the 7V overvolt rails. All others are tied to the 15V overvolt rails. ■



The analog computer printed circuit foil pattern.

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BP92: ELECTRONICS SIMPLIFIED - CRYSTAL SET CONSTRUCTION $5.25
This is a book written especially for those who wish to participate in the intricacies of electronics.

BP192 $8.00
More Advanced Power Supply Projects, by Robert Penfold. A companion to BP76, this book covers switched mode supplies, precision regulators, tracking regulators, computer-controlled supplies, etc.

BP197: AN INTRODUCTION TO THE AMSTRAD PCs $20.00
Recently introduced to Canada, the Amstrad PC is an MS-DOS computer for general and business use. This book explains all you need to know to start computing.

BP:150 AN INTRO TO PROGRAMMING THE SINCLAIR QL $7.80
Helps the reader make the best use of the Sinclair QL's almost unlimited range of features. Complements the manufacturer's handbook.

BP48: ELECTRONIC PROJECTS FOR BEGINNERS $7.80
F.G. Rayer, T. Eng. (CEI), Assoc.IERE
Another book written by the very experienced author — Mr. F.G. Rayer — and in it the newcomer to electronics, will find a wide range of easily made projects. Also, there are a considerable number of actual components and wiring layouts, to aid the beginner.

BP135: SECRETS OF THE COMMODORE 64 $5.85
This book is intended as a beginner's guide to the Commodore 64.

BP155: INTERNATIONAL RADIO STATIONS GUIDE $9.00
An invaluable aid in helping all those who have a radio receiver to obtain the maximum entertainment value and enjoyment from their sets.

BP130: MICRO INTERFACING CIRUITS - BOOK 1 $9.00
Aimed at those who have some previous knowledge of electronics, but not necessarily an extensive one, the basis of the book is to help the individual understand the principles of interfacing circuits to microprocessor equipment.

BP51: ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING $5.85
This book sets out to show how Electronic Music can be made at home with the simplest and most inexpensive equipment.

BP222: SOLID STATE SHORT WAVE RECEIVER FOR BEGINNERS
R.A Penfold $7.80
In this book, R.A. Penfold has designed and developed several modern solid state short wave receiver circuits that will give a fairly high level of performance, despite the fact that they use only relatively few and inexpensive components.

BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R.A. Penfold $7.80
We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

BP74: ELECTRONIC MUSIC PROJECTS $10.00
R.A. Penfold
Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as a Fuxx Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremelo Generator etc.

BP 234: TRANSISTOR SELECTOR GUIDE $15.00
Listings of British, European and eastern transistor characteristics make it easy to find replacements by part number or by specifications. Devices are also grouped by voltage, current, power, etc., includes surface-mount conversions.

BP50: IC LM3900 PROJECTS $4.25
The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and Hobbyist. It provides the groundwork for both simple and more advanced uses and is considerably more than just a collection of simple circuits or projects.

BP233: ELECTRONIC HOBBYIST HANDBOOK $15.00
A single source of easily located information: colour codes, pinouts, basic circuits, symbols, etc.

BP101: HOW TO IDENTIFY UNMARKED IC's $1.95
An unusual and fascinating chart that is highly recommended to all those interested in electronics and which will hopefully pay for itself many times over, by enabling the reader to use IC's that might otherwise have been scrapped.

BP121: HOW TO DESIGN AND M[illegible] YOUR OWN PCBs
The purpose of [illegible] familiarise [illegible] ple a[illegible] [illegible] boards. [illegible] book is very [illegible] practical aspects of [illegible] circuit board design and construction.

TEMPORARILY OUT OF PRINT

BP180: ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF MODEL RAILWAYS $9.00
Shows how home computers can easily be applied to the control of model railroads and other quite sophisticated control. A variety of projects are discussed as well as circuits for train position sensing, signal and electric points control etc.

BP185: ELECTRONIC SYNTHESISER CONSTRUCTION $9.00
With this book a relative beginner should be able to build, with the minimum of difficulty and at a reasonably low cost, a worthwhile monophonic synthesiser and also learn a great deal about electronic music synthesis in the process.

BP115: THE PRE-COMPUTER BOOK $5.85
Aimed at the absolute beginner with no knowledge of computing, this entirely non-technical discussion of computer bits and pieces and programming is written mainly for those who do not possess a microcomputer but either intend to one day own one or simply wish to know something about them.

BP72: A MICROPROCESSOR PRIMER $5.25
In an attempt to give painless approach to computing, this inexpensive book will start by designing a simple computer and then the shortcomings of this simple machine will be discussed and the reader is shown how these can be overcome. A glossary of microprocessor terms is at the end of the book.

BP78: PRACTICAL COMPUTER EXPERIMENTS $5.25
The aim of this book is to enable the reader to simply and inexpensively construct and examine the operation of a number of basic computer circuit elements and it is hoped gain a fuller understanding of how the mysterious computer "chip" works.

BP86: AN INTRODUCTION TO BASIC Programming Techniques $5.85
This book is based on the authors own experience in learning BASIC and also in helping others, mostly beginners to programming, to understand the language.

BP42: 50 SIMPLE L.E.D. CIRCUITS $5.85
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components.

BP85: INTERNATIONAL TRANSI STOR EQUIVALENTS GUIDE $9.00
This book is designed to help the user find possible substitutes for a popular user-oriented selection of modern transistors and includes devices produced by over 100 manufacturers.

BP140: DIGITAL IC EQUIVALENTS AND PIN CONNECTIONS $15.00
Shows equivalents and pin connections of a popular user orientated selection of Digital Integrated Circuits. Includes European, American and Japanese devices.

BP131: MICRO INTERFACING CIRCUITS - BOOK 2 $9.00
Intended to carry on from Book 1, this book deals with practical applications beyond the parallel and serial interface. "Real world" interfacing such as sound and speech generators, temperature and optical sensors, and motor controls are discussed using practical circuit descriptions.

BP100: AN INTRODUCTION TO VIDEO $5.85
This is a book for the person who has just, or is about to buy or rent some video equipment but is not sure what it is all about.

BP125: 25 SIMPLE AMATEUR BAND AERIALS $5.85
This book describes how to build 25 amateur bank aerials. The designs start with the simple dipole and proceed to beam, triangle and even a mini-rhombic.

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BP141: LINEAR IC EQUIVALENTS AND PIN CONNECTIONS
ADRIAN MICHAELS $23.80
Find equivalents and cross-references for both popular and unusual integrated circuits. Shows details of functions, manufacturer, country of origin, pinouts, etc.,. includes National, Motorola, Fairchild, Harris, Motorola, Intersil, Philips ADC, AMD, SGS, Teledyne, and many other European, American, and Japanese brands.

BP156: AN INTRODUCTION TO QL MACHINE CODE $10.00
The powerful Sinclair QL microcomputer has some outstanding capabilities in terms of its internal structure. With a 32-bit architecture, the QL has a large address range, advanced instructions which include multiplication and division. These features give the budding machine code programmer a good start at advanced programming methods. This book assumes no previous knowledge of either the 68008 or machine code programming.

See order form in this issue.

BP7: RADIO AND ELECTRONICS COLOUR CODE AND DATA CHART $3.00

Opens out to Wall Chart approximately 584 x 457 mm. Includes many Radio & Electronics Colour Codes in use in UK, USA, Europe and Japan. Covers Resistors, Capacitors, Transformers, Field Coils, Fuses. Battery Leads etc.

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This book covers many aspects of electronics where a knowledge and familiarity of the appropriate formulae is essential for a fuller understandings of the subejct. An essential addition to the library of all those interested in electronics be they amateur, professional or student.

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BOOOK 3. Follows on semiconductor technology, leading up to transistors and integrated circuits.

BOOK 4 A complete description of the internal workings of microprocessor.

BOOK5 A book covering the whole communication scene.

BP180: ELECTONIC CRICUITS FOR THE COMPUTER CONTROL OF MODEL RAILWAYS $9.00

The projects in this book consists of various types of controller, including a high quality pulse type, as well as circuits for train position sensing, signal and electronic points control and many more.

BP194:: MODERN OPTO DEVICE PROJECTS $9.00

This book provides a number of practical designs for beginners and experienced project builders. These projects utilize a range of modern opto-electric devices, including such things as fibre optics, ultra bright LEDs and passive IR detectors.

BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS $7.80
F.G. RAYER, T.Eng.(CEI),Assoc. IERE

Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of applications in electronics today. This book gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaptation of them to individual needs.

BP147: AN INTRODUCTION TO 6502 MACHINE CODE $10.00

The popular 6502 microprocessor is used in many home computers; this is a guide to beginning assembly language.

BP225: A PRACTICAL INTRODUCTION TO DIGITAL ICs $7.00

This book deals mainly with TTL type chips such as the 7400 series. Simple projects and a complete practical construction of a Logic Test Circuit Set are included as well as details for a more complicated Digital Counter Timer project.

BP47: MOBILE DISCOTHEQUE HANDBOOK $7.80

Divided into six parts, this book covers such areas of mobile "disco" as: Basic Electricity, Audio, Ancillary Equipment, Cables and Plugs, Loudspeakers, and Lighting. All the information has been considerably subdivided for quick and easy reference.

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This book carries on from its predecessor and provides a further selection of useful circuits, mainly of a simple nature. the book will be well within the capabilities of the beginner and more advanced constructor.

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R.A. PENFOLD

Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as '2 Tone Door Buzzer' intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

BP44: IC 555 PROJECTS $10.00
E.A. PARR, B.Sx., C.Eng., M.I.E.E.

Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

BP82: ELECTRONIC PROJECTS USING SOLAR CELLS $7.80

A collection of simple circuits which have applications in and around the home using the energy of the sun to power them. The book deals with practical solar power supplies including voltage doubler and tripler circuits, as well as a number of projects.

BP95: MODEL RAILWAY PROJECTS $7.80

Electronic projects for model railways are failry recent and have made possible an amazing degree of realism. The projects covered include controllers, signals and sound effects: striboard layouts are provided for each project.

BP93: ELECTRONIC TIMER PROJECTS $7.80

Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub-circuits which are dealt with individually.

BP94: ELECTRONIC PROJECTS FOR CARS AND BOATS $7.80
R.A. PENFOLD

Projects, fifteen in all, which use a 12V supply are the basis of this book. Included are projects on Windscreen Wiper Control, Courtesy Light Delay, Battery Monitor, Cassette Power Supply, Lights Timer, Vehicle Immobiliser, Gas and Smoke Alarm, Depth Warning and Shaver Inverter.

BP49: POPULAR ELECTRONIC PROJECTS $10.00
R.A. PENFOLD

Includes a collection of the most popular types of circuits and projects which, we feel sure, will provide a number of designs to interest most electronics constructors. The pro jects selected cover a very wide range and are divided into four basic types. Radio Projects, Audio Projects, Household Projects and Test Equipment.

BP84: DIGITAL IC PROJECTS $7.80
F.G. RAYER, T.ENG (CEI), Assoc.IERE

This book contains both simple and more adanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. to help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be build and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

BP99: MINI - MATRIX BOARD PROJECTS $7.60
R.A. PENFOLD

Twenty useful projects which can all be built on a 24 x 10 hole matrix board with copper strips. Includes Doorbuzzer, Low-voltage Alarm, AM Radio, Signal Generator, projector Timer, Guitar Headphone Amp. Transistor Checker and more.

BP103: MULTI-CIRCUIT BOARD PROJECTS $7.80
R.A. PENFOLD

This book allows, the reader to build 21 fairly simple electronic projects, all of which may be constructed on the same printed circuit board. Wherever possible, the same components have been used in each design so that with a relatively small number of components and hence low cost, it is possible to make any one of the projects or by re-using the components and P.C.B. all of the projects.

BP107: 30 SOLDERLESS BREAD-BOARD PROJECTS - BOOK 1 $9.00
R.A. PENFOLD

A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featued in this book have been specially deisgned to be built on a 'Verobloc'' breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.

BP127:HOW TO DESIGN ELECTRONIC PROJECTS $9.00

Although information on stand circuit blocks is available, there is less information on combining these circuit parts together. This title does just that Practical examples are used and each is analysed to show what each does and how to apply this to other designs.

BP122: AUDIO AMPLIFIER CONSTRUCTION $6.75

A wide circuits is given, from low noise microphone and tape head preamps to a 100W MOSFET type. There is also the circuit for 12V bridge amp giving 18W. Circuit board or stripboard layout are included. Most of the circuits are well within the capabilities for even those with limited experience.

BP106: MODERN ON AMP PROJECTS $7.80
R.A. PENFOLD

Features a wide range of constructional projects which make use of op-amps including low-noise, low distortion, ultra-high input impedance, high slew-rate and high output current types.

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 $9.00
R.A. PENFOLD

70 plus circuits based on modern components aimed at those with some experience.

BP179: ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL O ROBOTS

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BP195: AN INTRODUCTION TO SATELLITE TELEVISION $15.00

For the absolute beginner or anyone thinking about purchasing a satellite TV system, the story is told as simply as such a complex one can be in the main text.

BP108: $7.00

Cross-references European American and Japanese diode part numbers. Besides rectifier diodes, it includes Zeners, LEDS, Diacs, Triacs, SCRs, OCIs, photodiodes and display diodes.

BP88: HOW TO USE OP AMPS
E.A.PARR $11.80

A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as nonmathematical as possible.

BP65: SINGLE IC PROJECTS $6.00
R.A. PENFOLD

There is now a vast range of ICs available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

BP118: PRACTICAL ELECTRONIC BUILDING BLOCKS - BOOK 2 $7.60
R.A. PENFOLD

This sequel to BP117 is written to help the reader create and experiment with his own circuits by combining standard type circuit building blocks. Circuits concerned with generating signals were covered in Book 1, this one deals with processing signals. Amplifiers and filters account for most of the book but comparators, Schmitt triggers and other circuits are covered.

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THE SCIENTISTS TELL ME

DAVID P. DEMPSTER

Making CIM Safe for Computers

With the rise of computer-integrated manufacturing (CIM) in the automotive, aerospace and other industries, the demand has grown for computers that can withstand the harsh, dirty environments in many industrial facilities.

A challenge to computer makers has been to design cabinetry that protects delicate internal mechanisms against malfunctions caused by dirt, dust, metal particles and other potential contaminants. Also targeted is a means to achieve internal cooling without the need for costly built-in refrigeration units. And it appears that Digital Equipment Corporation, Maynard, Massachusetts, has succeeded in meeting the challenge with three new industrial computers in fully sealed NEMA 12 enclosures that feature a unique passive cooling system.

To cool the 16-in. wide by 19-in. tall units, a series of about 45 aluminum vents, which run from the base to the top cover on three sides of the enclosure, conduct heat outward without allowing external air to circulate back in. An integral feature of this passive cooling design, according to George Doumani, consulting engineer for Digital, is the encapsulation of the top and bottom portion of the aluminum vents with RIM (reaction injection moulded) polyurethane structural foam.

The resin, which is naturally adhesive, bonds strongly to the metal to provide a durable, aesthetic finish where vents are visible, and allows for the box to be sealed easily and economically.

The manufacturing process permits the aluminum vents to be encapsulated in a closed steel mould using the RIM process. Covering about 4 inches on the top and bottom of the vents, the polyurethane structural foam is moulded at an average 1/4-in. thickness.

After the vents are removed from the mould, sheet metal is riveted to the interior side, and another sheet is adhesive- bonded to the outside. This forms a cavity through which air driven by a small internal fan can circulate. The thermal conductivity of the aluminum promotes the transfer of heat out of the unit.

The enclosures for these units meet U.S. NEMA 12 standard requirements for protection against dust, falling dirt and dripping noncorrosive liquids.

The new computers, which incorporate the company's VAX architecture, are: 1) the Industrial VAX 630 (IVAX 630) for supervisory and/or area control, 2) the Industrial PDP-11 (IPDP- 11) for PDP-based manufacturing applications, and 3) the Industrial VAX (IVAX 620) system for dedicated realtime applications.

Biotechnology Products Undergo Impact Assessment

Before products of the burgeoning biotechnology industry can be released into the environment, laboratory testing methods must assess their potential environmental impact. Researchers at the Battelle Memorial Institute's Northwest Laboratories are developing testing methods to meet the need under contract from the U.S. Environmental Protection Agency.

Genetically engineered micro-organisms are living organisms, such as bacteria and fungi, whose genetic characteristics have been altered. They can be developed and tested in a contained laboratory or contained greenhouse, but outdoor tests require approval from a federal agency such as EPA. In April, EPA approved the first open-air application of genetically engineered bacteria, and Advanced Genetic Sciences, a biotechnology research and development firm, sprayed a frost-inhibiting bacteria on strawberry plants in a 0.1-acre test plot in California.

"Disease- and herbicide-resistant plants, insecticide-producing bacteria that protect crops and plants, and oil and chemical waste-eating bacteria are examples of laboratory-developed genetically engineered microorganisms that are awaiting outdoor testing," says Dr. James K. Fredrickson, of Battelle's Earth and Environmental Sciences Center.

"However, understanding how genetically engineered microorganisms will behave once released

Fig. 1. The computer vent system starts life as a flat moulding. This photo illustrates a unit being removed from the mould after the aluminum vents have been encapsulated

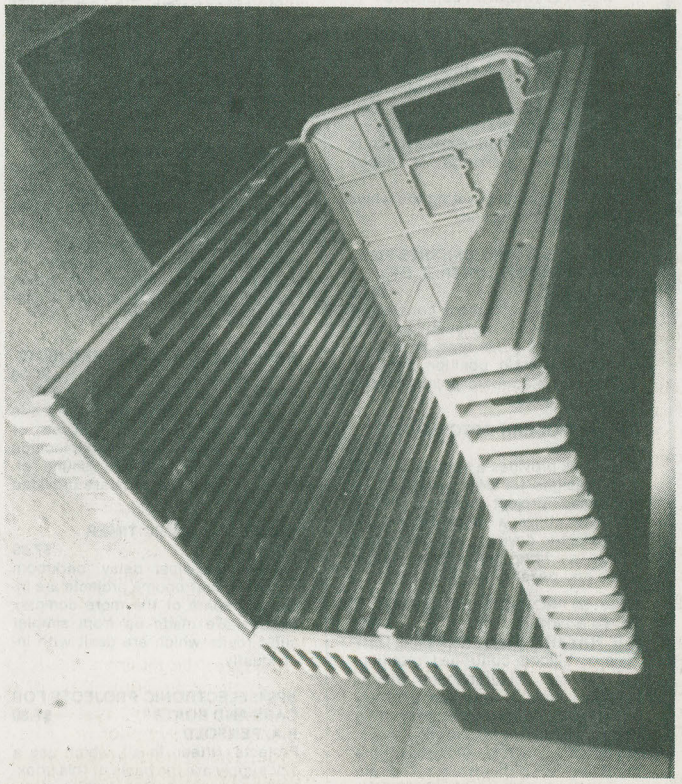

Fig. 2. Following removal from the mould, the flat element is bent into a U-shape to form three sides of the box. Sheet metal is then riveted to the interior side, and another sheet is adhesive bonded to the exterior. This forms a cavity through which air driven by a small internal fan can circulate.

into the environment is essential before EPA and other agencies can issue permits to conduct further field experiments," he continues.

"Knowing how these organisms will react is important since they cannot be recalled once they have been released into the ecosystem."

Opponents of field testing are concerned that genetically engineered microorganisms could harm insects, animals or crops, or cause human health problems. They also fear these organisms could displace other indigenous organisms, or that herbicide- resistant plants might evolve into "superweeds," immune to normal eradication techniques.

Battelle researchers will examine a variety of soil samples for the effects of genetically engineered microorganisms on the soil's nutrient cycle and the displacement of other environmentally important microorganisms.

The researchers will use natural or unaltered, microorganisms to develop testing methods for genetically engineered organisms. "These environmental monitoring techniques that use natural genes can be adapted to monitor bacterial containing engineered genes," Fredrickson notes.

"The testing methods will help determine rates of survival, growth movement, reproduction, fate and the potential effects of genetically engineered microorganisms," he says.

Previous exploratory research at Battelle established methods for detecting and tracing genetically engineered microorganisms in a wide variety of soil samples by using methods such as gene probes. The research also established capabilities to determine the fate of these organisms and their effects on the ecosystem. Techniques developed in what research will continue through the summer.

Stackliners, Bigger and Better with FRP

The stack liner shown in the photo is inspected prior to installation in the 682- foot high reinforced concrete chimney of the Intermountain Power Project near Delta, Utah. The liner, made of fibreglass- reinforced-polyester — the same material that is used for fibreglass boats — protects the concrete shell from corrosive gases.

Engineered and manufactured by Ershigs, Inc. Bellingham, Washington, the liners are 28-feet in diameter. The completed liner will contain some 100 thousand miles of fibreglass strand.

New Materials Challenge Metals, Glass

Advanced plastics and other "high-tech" materials will continue making inroads in markets traditionally dominated by the metals and glass industries, according to a new report from the U.S. Interior Department's Bureau of Mines. The report examines the displacement of conventional mineral-based materials—steel, aluminum, and glass—by plastics and ceramics, and predicts substitution trends through the end of the century for major industries.

Advanced materials—which include higher-performance plastics and plastic-based composites (like the chimney liner described above)—have gained customers at the expense of traditional mineral products in recent years. According to the Bureau, the 1990s will see even more intense competition in materials markets, particularly between high performance plastics and metals.

These plastics have already replaced as much as 7 to 9 percent of the steel used in manufacturing cars and trucks in North America. The Bureau's study projects that plastics may displace more than double that amount by the year 2000.

The aerospace industry is expected to make an even more dramatic shift away from its traditional reliance on metals. The Bureau predicts that composites will replace from 20 to 60 percent of the aluminum used in the airframes of commercial airliners during the next decade.

Higher substitution rates are anticipated for the military sector of the industry. Defence contractors, who face fewer obstacles in adopting new materials, have already made significant use of plastic composites to reduce the weight and improve the performance of their aircraft.

The Bureau's study shows plastics gaining ground against metals in the construction and heavy machinery industries and against metals and glass in the packaging industry. Advanced ceramics are not expected to present a serious challenge to metals until well into the next century. The thermal strength and hardness of these materials, however, assures their eventual use in the aerospace and automotive industries.

The report also identifies those factors that affect the rate at which industry accepts new materials. Performance and cost are important concerns. Manufacturers will also consider the "track record" of the new product and the availability of the raw materials, tooling, parts, equipment, and technical expertise needed to adopt it.

Efforts in the mining industry to improve the competitiveness of its products will also play a role in shaping materials consumption in the next decade, the report notes. Metal producers, for example, have developed lightweight aluminum-lithium alloys to compete with plastics in the aerospace industry and new steels specially designed to match the requirements of automobile manufacturers. ■

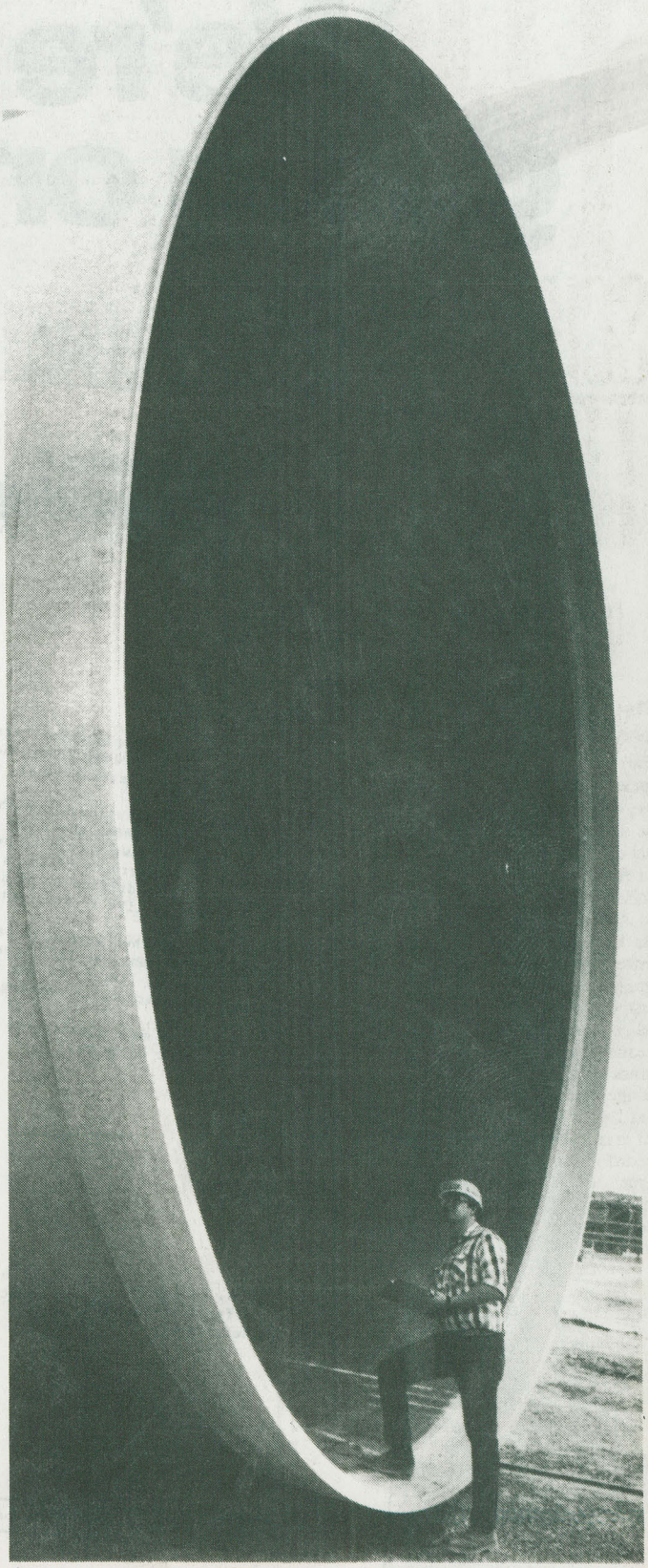

Fig. 3. A 682-foot chimney tsack liner is inspected before installation in the cimney of a power project in Utah. The 28-foot-diameter liner contains some 100,000 miles of fibreglass strand.

We're One, going on twelve.

Electronics & Technology Today
Canada's Magazine for High-tech Discovery

Dear Reader,

This issue we complete our first year in our new format as Electronics & Technology Today, having started in 1977 as Electronics Today International.

We value our relationship with every reader, and we would like to hear what you think about the past year, and also what you think about where we should be headed. You don't have to pull any punches: we're aware of reader's arguments about computer content, and the difficulty of sources for project parts. These are points we'd like to work out, with your input, of course.

If you feel that we should back down on the science and technology content, we'll listen. If you think we should modify projects, we'll listen. If you think we should change the amount of consumer electronics coverage, we'll listen.

We want to make Electronics & Technology Today the magazine that you want it to be.

Sincerely,

William Markwick

William Markwick, Editor

P.S. Because it's our anniversary, we'd like to extend a special offer to you: a year's subscription at 1977 prices. See the details on the next page.

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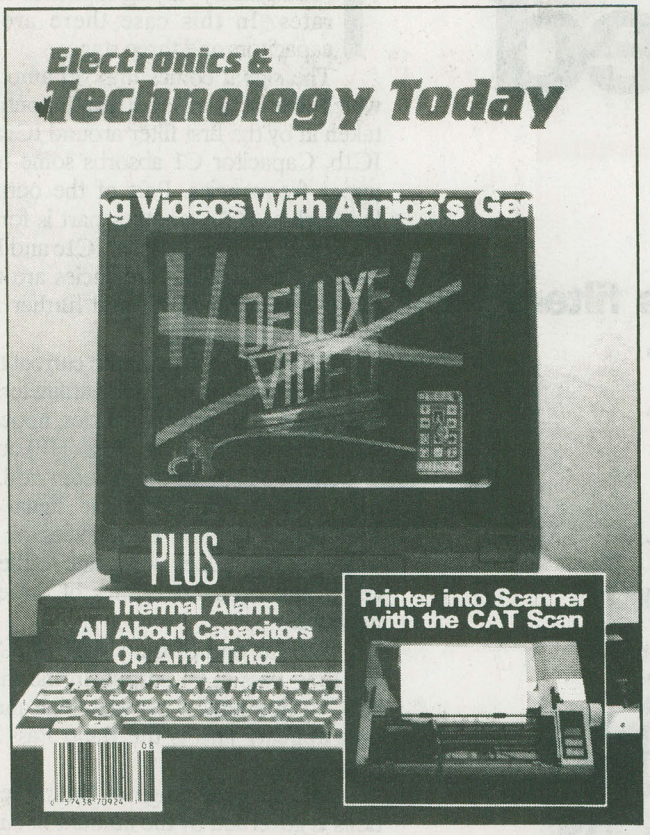

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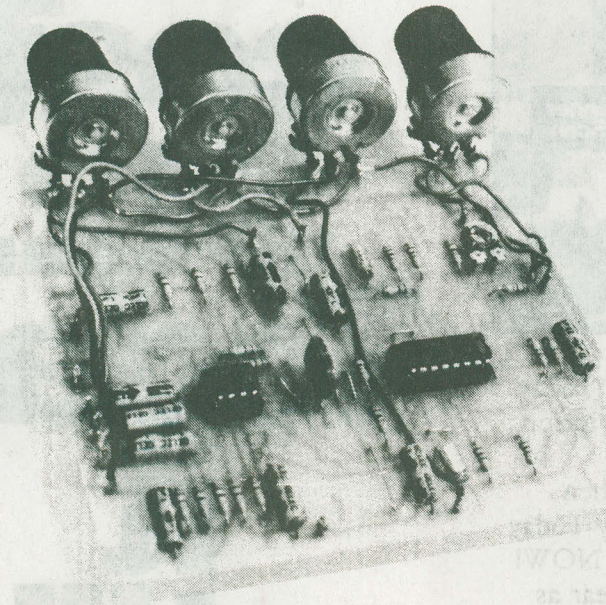
Voltage Controlled Filter

Highpass, lowpass and bandpass filters for creating sound effects.

JOHN BECKER



The principle of operation of the voltage controlled filter (vcf) is shown in the circuit diagram, Fig. 1, and is similar to that for the low pass filter. Frequencies are extracted from an AC signal by varying capacitor charge rates. In this case there are two capacitors and three stages.

The signal comes into op amp IC2a which acts as a mixer stage. Its output is taken in by the first filter around IC1a and IC1b. Capacitor C1 absorbs some of the upper frequencies. Part of the output is fed back to IC1a, another part is forward to the second filter stage at IC1c and IC1d. More of the upper frequencies are taken out by capacitor C15 , and further feedback is made to IC2a.

Due to the nature of the current transfer, three frequency pass parameters are developed. Upper frequencies appear at IC2a, and this is the High Pass (HP) output.

At first sight this may seem odd, as it might be expected that the signal here should contain low frequencies as well. The fact that it does not is due to the current transfer characteristics of the entire network.

The far end of the circuit at IC1d is the Low Pass (LP) output. In the middle at IC1b, frequencies between high and low pass appear. This is the Band Pass (BP) output.

The spectral range of the three sections is governed by the amount of current going into the control nodes at pins 1 and 16. Since these are coupled, they both see the same current as delivered from the chosen sources previously discussed.

Filter response in respect of varying values of node current and capacitance value is shown in Graph 3. The maximum and half level regions shown relate to the signal strength seen at the outputs compared to the original level.

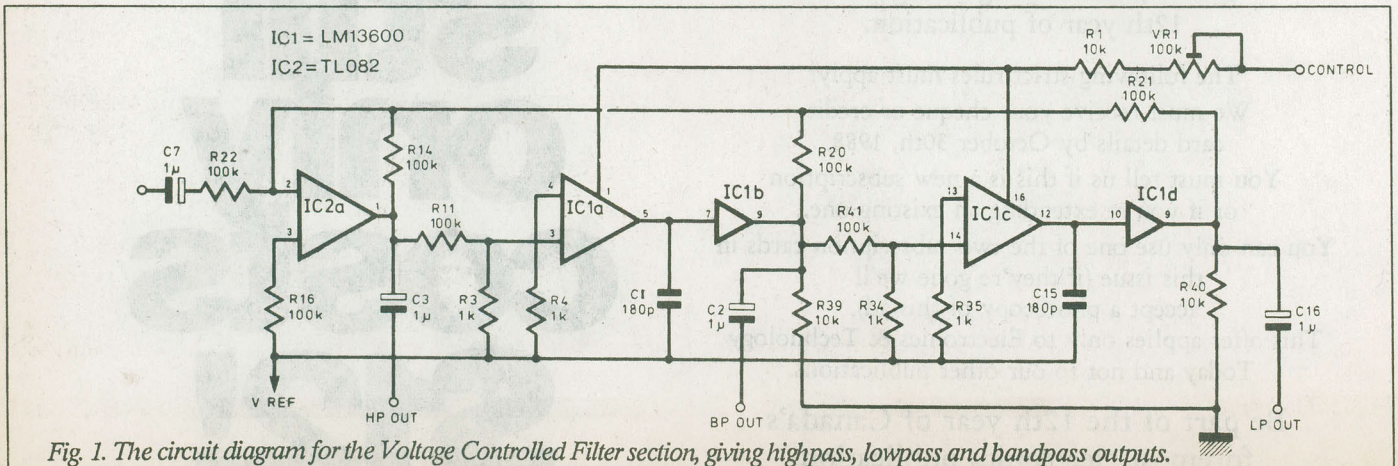


Fig. 1. The circuit diagram for the Voltage Controlled Filter section, giving highpass, lowpass and bandpass outputs.

SOFTWARE CATALOGUE
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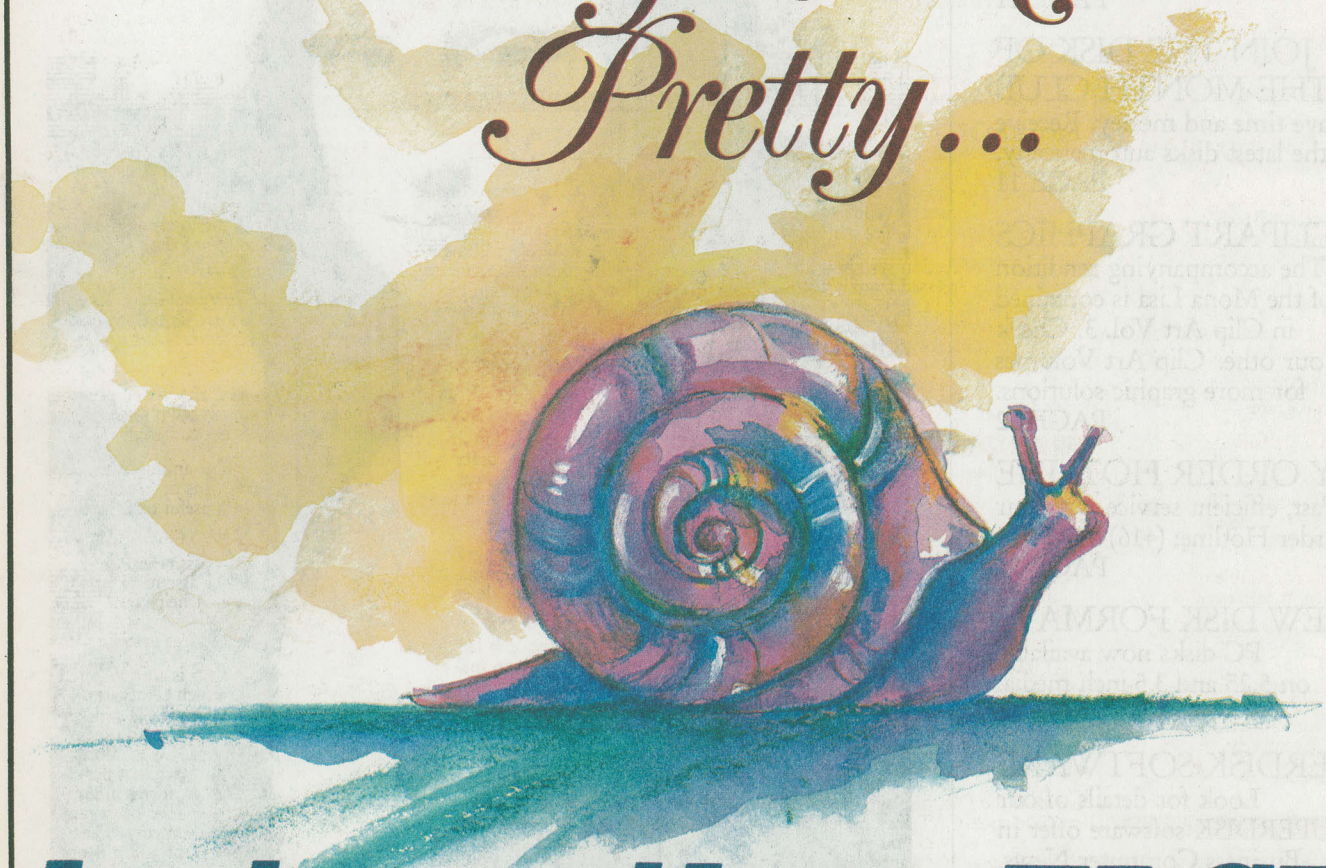

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VOLUME 1

PC-WRITE An earlier, compact version of this well- known word processor — perfect for program editing. PC-Write boasts features such as user-definable help screens and a 'printer ruler file' which can be customized to work with virtually any printer.

SOLFE is a small BASIC program that plays baroque music. While it has little practical use, it's a lot of fun. It's also a fabulous tutorial on how to use BASICA's sound statements.

PC-TALK A high-power telecommunications program for a low-power price. It does file transfers in both ASCII dump and MODEM7/-XMODEM protocols. And, it comes with a large documentation file.

SD This sorted directory produces displays which are a lot more readable that those spewed out by typing DIR.

FORTH This is a small FORTH, written in Microsoft BASIC. A good tool for teaching the ideas and concepts of this esoteric, but useful language.

LIFE This is an implementation of the classic ecology game written in 8088 assembler code.

MAGDALEN This is another BASIC music program.

CASHACC is a fairly sophisticated cash acquisition and limited accounting package written in BASIC. It isn't exactly BPI, but it's a lot less expensive and suitable for many small business applications.

DATAFILE is a simple data base manager, written in Microsoft BASIC.

UNWS Convert WordStar documents to standard ASCII files.

HOST2 This program includes BASIC source and documentation files to allow users with SmartModems to access their PC's remotely.

$19.95

VOLUME 2

SWEEP is a disk utility which virtually replaces the DOS COPY, REN, TYPE and DEL commands.

WORLDMAP is a sophisticated graphics program which draws a very detailed map of the world. It can display its wares on your monitor, or send them out to a dot-matrix printer. CGA required.

ANITRA plays Anitra's Dance by Edvard Grieg. A beautiful addition to your computer music collection.

RAMDISK is one of the most useful utilities you'll ever plug into your PC. Once installed, it creates a virtual drive in memory on your PC.

ALIEN Plays a bizarre adventure game and will lead you into some of the most exotic spots in the universe.

FOS is a well designed personal finance manager which will do much to help you tame your cheque books.

JUKEBOX represents yet another PC music system. This one comes with a host of songs and some really electric graphics.

ASMGEN is one of the best text disassemblers we've come across. It takes any executable COM or EXE file and produces an assembler listing. It's surprisingly good at distinguishing between code and embedded data or text.

STRUCT will appeal to the rabid programmer in everyone. It enables MASM to be used to assemble a higher level language. Included also is a test file to illustrate the syntax.

PRTSC replaces the internal PC screen dump code with something more suited to reality. It allows one to hit the PrtSc* key and then select the print quality from a menu. It supports a number of popular printers.

BREAKOUT plays a PC version of the popular game. It will accept input from either a joystick or the keyboard. The graphics are good and the action is adjustable from a beginner's level right up to 'fast and nasty'.

UTIL is a collection system utilities which can be accessed from a single menu. Among its talents are a sorted directory, keyboard redefinition and the facility for scrolling through text files.

$19.95

VOLUME 3

WRT DOS allows files to have a 'read only' flag, but it lacks a way of manipulating them. This pair of utilities allows you to set and unset this flag, protecting files from accidental erasure.

BROWSE is a timesaving program which provides a useful alternative to the DOS 'TYPE' command. BROWSE allows you to easily scroll through text files in order to have a quick look at a text file.

CAT If the DIR display is too dull for your taste, CAT may be just what you need. It will tell you everything you could possibly want to know about the files on your disks.

CGCLOCK is a simple little program which displays the running time in the upper right hand corner of your screen. Works with CGA displays.

CURSOR A tiny twenty-four byte program which displays a large cursor on your monitor.

CMP This program does a very elaborate comparison of two files and reports their differences.

JUMPJOE A bit like "Miner 2049'er", this game is certain to damage your mind. You get to be the janitor of a space station and deal with berserk robots and other weirdness.

CASTLE Wander through a deserted castle collecting treasures... but mind you don't get killed by the nasties. A solution is included should frustration set in.

78INT This small BASIC program calculates interest using the rule of seventy-eight.

MOON is one of the nicest lunar lander games we've come across. This version uses high resolution graphics and startling sound effects to hurl you to your doom in style.

PERTCHT is a BASIC program which prints PERT charts. It should interest anyone involved in project management and scheduling.

DATNOIDS is one of the strangest games ever put on a disk. In fact, mere words don't serve to describe it: you'll have to try it for yourself.

NUK-NY This is one of the nastiest bits of software we've ever seen. It produces a full color high resolution simulation of a nuclear attack on New York City.

$19.95

VOLUME 4

BACKSCROLL Perhaps one of the cleverest DOS utilities, BACKSCROLL hooks itself into the PC and buffers whatever scrolls by. Using a well-thought out command structure, it allows one to scroll through text which has already scrolled off the screen into oblivion.

BIGCAL is a BASIC program which performs calculations on extremely large numbers.

BUGS is an off the wall ASCII game in which a player uses the cursor pad keys to move a 'nuclear fly swatter' around the screen blowing up a long crawling bug.

CRYPTO is a BASIC program which unscrambles cryptograms. It's an interesting study for puzzle enthusiasts.

DEFRAG is a utility that lets you "de- fragment" your disks to make your applications run faster. The utility reorganizes a disk, connecting up the fragments of files created by DOS.

DOSEDIT enhances the command line facility of MS-DOS by creating a command stack. Instead of merely being able to recall a command with the F3 key, DOSEDIT lets you use the cursor arrow keys to scroll through a whole stack of previously entered commands, re-executing the ones you need.

DUMP is a utility program designed to produce Hex dumps of object files.

FREE is a tiny file which tells you how much space is left on a disk... without having to view an entire directory listing.

KBFIX displays the status of the keyboard lock keys on the screen and expands the size of the keyboard character buffer to avoid losing bytes.

LABEL changes the labels on disk drive volumes. It's a simple utility, but useful if you use volume labels to keep track of your disks.

LIST is an improved version of the DOS TYPE command which shows you the contents of a file page by page.

MEMBRAIN is the most sophisticated RAM disk program we've seen yet. It lets users install variable sized disks and provides control over several other parameters.

MONOCLOK is a screen clock display program, designed specifically to work with monochrome displays.

MOVE is a disk utility which moves and optionally erases disk files. Using wild cards, the user can ensure that specific types of files are not MOVED by the program.

NEWBELL is a tiny program which performs the lowly task of changing the sound of the PC's control G beep.

NUSQ is a file un-squeezer. Its a useful utility for people who download compressed files from bulletin board systems.

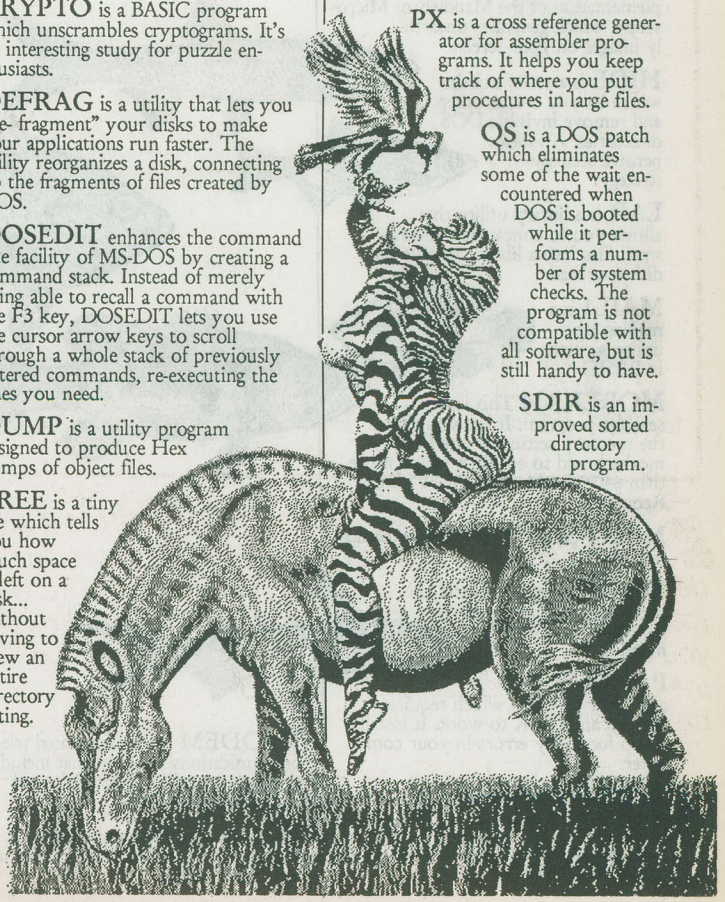
PARCHK is a trap which prevents the system from 'freezing' when a "parity error" is encountered.

PURGEDUP is an intelligent little program which cleans up obsolete backup files. Very useful on a hard drive.

PX is a cross reference generator for assembler programs. It helps you keep track of where you put procedures in large files.

QS is a DOS patch which eliminates some of the wait encountered when DOS is booted while it performs a number of system checks. The program is not compatible with all software, but is still handy to have.

SDIR is an improved sorted directory program.



SP is a clever print spooler which lets you 'print' files into a RAM buffer, leaving the user free to move on to other tasks using the computer.

SPACE INVADERS A fast variation of this popular arcade game. The graphics are superb.

SPEED is a simple program which changes some of the PC's floppy disk parameters and effectively speeds up disk accesses for some applications.

VDEL is a multiple deletion program that queries the user prior to erasing each entry. Similar to MOVE, but much smaller.

WHEREIS will locate a file on a disk even if it lurks in a subdirectory. Most useful on hard disk systems.

WIZARDS is an adventure game in the classic style, except that it ranks as one of the most sarcastic programs in creation. The program is vast... you can wander about its darkened corridors for hours.

$19.95

VOLUME 5

AREACODE is a useful tool if you use the telephone a lot. Give it an area code and it will match it with the city in which the code is used.

D in another sorted directory program. This one emulates the CP/M style D, which is arguably more useful for most applications.

FRACTALS An amazing implementation of the Mandlebrot Microscope, which generates unearthly images on your screen.

HIDE is a set of utilities which let you create, enter and remove invisible DOS directories. An inexpensive security strategy.

LAR is a library utility that allows you to concatenate several small files into a library to save on disk overhead.

MAIL1 is a mailing label utility written in BASIC.

MORERAM This is an assembler program. It lets you alter the memory setting on the PC's motherboard to enable it to use more than 640K RAM. MASM & LINK Required.

MORTGAGE generates amortization charts.

MXSET lets you control the parameters of Epson printers from the DOS command line.

PARCHK is an assembler program which requires MASM and LINK to work. It installs a trap for parity errors in your computer.

VDEL is a Delete with Verify program.

WHEREIS finds files in a complex hard disk system.

ZAXXONPC This is an incredible implementation of one of the most popular micro games ever created.

$19.95

VOLUME 6

3-DEMON is one of the most interesting variations on Pac-Man in the known universe. Instead of simply looking at a map of a maze, this program shows you a three dimensional view of it.

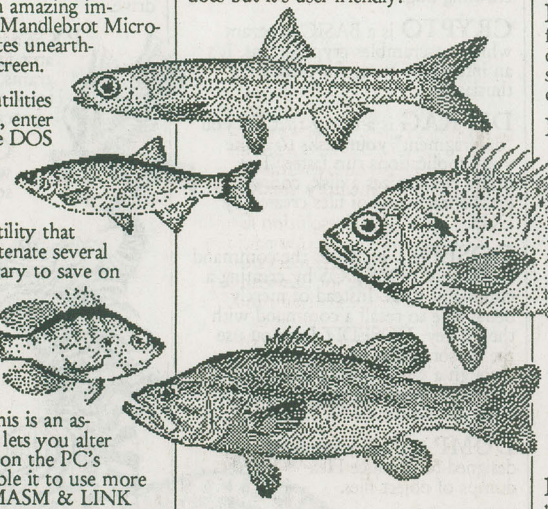
DU allows you to see what the tracks and sectors on your disks look like, recover erased or damaged files, and meddle with the system tracks.

GENERAL LEDGER This is a complete general ledger accounting program. Written in BASIC, the program possesses most of the features found in commercial packages. Documentation included.

PC-CHESS is a slick chess program which makes good use of the PC's colour graphics abilities and boasts a running chess clock.

RAMDISK is the assembler source code for a memory disk program. A great learning tool for budding assembler programmers.

VFILER is a file management utility which lets you view files in a directory and allows you to COPY, TYPE and even run programs... in short, it does almost everything DOS does but it's user-friendly.



QMODEM is a sophisticated telecommunications program that includes windowing, multiple protocols, and definable function keys.

ARC is a clever file archiving program which stores multiple files in single library files.

ZAPLOAD is a utility for programmers to handle Intel standard HEX files. Very fast and well documented.

SOPWITH Using superb graphics, SOPWITH lets you pilot a World War I biplane on dangerous bombing missions.

JSB Another BASIC music program for your collection. This one plays a soothing sonata.

STAR is one of a growing breed of small... somewhat silly... novelty programs. This one, as you might guess, draws stars.

SURFACE demonstrates the complexity of the "hat" function by graphing it.

OP is the operator program from the November '85 issue of Computing Now!

$24.95
(2 Disk Set)

VOLUME 7

BLACKJACK is a BASIC implementation of this popular card game.

EDSCR is a screen editor which can be used with virtually any programming language from assembler to dBase III.

FK allows you to make the function keys of your PC do more useful things under DOS.

FXMASTER is a printer program for the popular Epson FX Series and compatible printers. It uses a full screen menu to enable you to easily change printer settings and modes.

INDEX allows you to generate indexes from WordStar documents... or text files from any other text editor.

KEYCLICK is a memory co-resident program which will make your keys click.

PCBW is a small utility which makes colour screen displays show up in monochrome video. Great for users with colour graphics cards and monochrome monitors.

PINBALL is a pinball simulation that is easily worth the cost of this disk all by itself.

QUICKGRAF is a powerful business graphics package which generates complex bar, line and scatter charts in medium and high resolution. An Epson with GrafTrax or compatible printer is necessary to produce hardcopy.

SERPENT is a variation on the classic snake game. Written in BASIC, this one is weird, but very fast.

SHOWCLK is yet another clock program... its the smallest one yet, and it beeps to chime the hour.

VTREE is a graphic TREE program that shows you how the subdirectories are set up on your disk... in a fashion more easily understood than the MS-DOS TREE utility.

WORLD is a remarkable program incorporating a world map. It allows you to zoom in on specific areas of the globe, locate major cities and perform a number of useful calculations.

$19.95

VOLUME 8

DDCAL is a very clever perpetual calendar and desk diary. It keeps track of your appointments and performs several other functions.

PC-KEY DRAW is a remarkable public domain paintbox program which compares favorably with many commercial applications. It'll handle multiple screen images, business graphics and superb computer art — all in full colour.

CPU is a tiny program which tells you the effective speed of your system.

XRAY is a remarkable co-resident utility which monitors what a program is doing while it's busy doing it. It allows you to interrupt the execution of your code and a look inside.

GAME — well, there are no words for this program, or, at least, none that are printable. This program does use some suggestive language, and we recommend that young or sensitive users not boot it.

TUNE is a very small music generator which makes noises from within batch files.

CHASM, or cheap assembler, is just the thing if you want to get into assembly language programming but don't want to spring for the Microsoft macro assembler package.

GETDIR is a resident directory utility. It allows you to see what files are on your disks, even if you're in the middle of doing something else.

COPYPC, not to be confused with the commercial Copy II PC, is a quick disk backup utility.

LOOKIT is a full screen browsing program which lets you scroll forward and backwards through text files — sort of like a tiny word processor with no editing features.

SYSLOCK is a security device for hard disk users. By running this utility on your XT or compatible, access to your computer will only be granted to users with a valid password.

$24.95
(two disk set)

VOLUME 9

SMALL C is a restricted implementation of C, producing code which is compatible with Microsoft's MASM and LINK programs — you'll need these to get it going.

MAP is an interesting little utility

which will check how DOS is situated in the memory of your computer and tell you a number of things about it.

NOTE is the source file for the memory resident note pad which appeared in the March 1986 edition of Computing Now! It requires MASM and LINK to use.

PANGO is one of the wildest games we've come across for the PC. While its premise is a bit improbable, it's fast and weird — hours of fun.

PC-SPELL is a spelling checker written in BASIC. It's fast, accurate and easy to use. It can be listed if you want to see how it works, and comes with a large dictionary file and a utility to assist you in customizing it.

PEACOCK is a memory resident program which allows you to change the colours of your screen with alternate function keys.

RECOVER is a file recovery utility. It lets you look at your files one sector at a time in order to put the pieces back together.

SDB is a small relational database. It isn't dBASE III, but it also doesn't cost quite as much.

TALLY is a program which accurately counts the number of characters, words and lines in a file — all within your lifetime.

XENO edits the tracks and sectors of your disks in a user friendly format — or, at least, one that doesn't lunge for your throat every time you boot.

$19.95

VOLUME 10

MONOPOLY A good implementation of the classic board game. Great graphics and sound. Slightly sarcastic play.

D20 is the latest version of Steve's sorted directory program. This one uses DOS two calls and handles subdirectories.

EDIT is a lightning fast full screen editor, ideal for editing program source files, dBASE stuff or other ASCII phenomena.

BANNER takes mere text and prints it sideways on your printer — in gargantuan block letters that can be read from miles away if you have a good set of binoculars.

MORTGAGE is one of the nicest mortgage programs we've seen so far — lifelong debt and ruination has never been so well formatted.

QUICK speeds up your PC quite a bit by improving video response.

SPEECH is a rather remarkable little germ of code. It talks through the PC's internal squeaker speaker. The voice isn't exactly human, but it's understandable on most machines.

PC-AR is an accounts receivable package for the PC. It will take care of the records for a small or medium sized business quite well.

$19.95

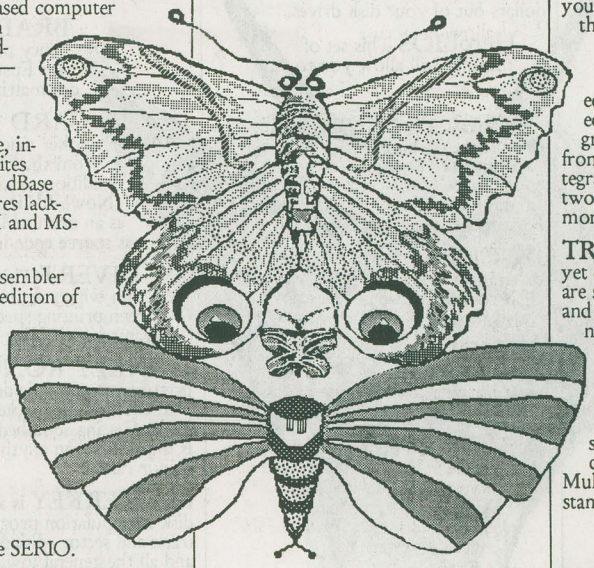
VOLUME 11

PAC GIRL is, predictably, a variation on the almost mythical Pacman game. This one moves fast, and plays much like the arcade version.

MENU lets you create a menu-driven tree-structured environment that is friendlier and more manageable than is DOS.

Z80MU is one of the most brilliant pieces of software we've ever encountered — free or not. It actually emulates a Z80- based computer running CP/M on the PC with no additional hardware — you don't even need a V20. It will run almost all CP/M software, including old favourites like WordStar and dBase and includes features lacking in both C/PM and MS-DOS.

SERIO is the assembler file from the July edition of Computing Now! that implements an interupt-driven terminal in higher level languages such as C. It's also suitable for use with compiled BASIC. Both MASM and Link are required to use SERIO.



BREAKDOWN is a peculiar program which takes meaningful text, analyzes it and generates meaningless, but profound- sounding prose from it. If you've been wondering if your co-workers really read your office memos and reports, try filtering your prose through this program. The effects will be astounding.

XMODEM is a C language implementation of the XMODEM file transfer protocol, from the July 1986 edition of Computing Now!. It can be integrated into other programs to allow easy access to telecommunications facilities. This code requires SERIO (see above) and version three Lattice C.

GRABIT is the screen grab program from the July 1986 edition of Computing Now!. It will make a useable text file from the contents of ones screen at the touch of a key. MASM are Link are required.

$19.95

VOLUME 12

CV is a small utility for changing the volume name on disks.

BREAKOUT BOX is an assembly language program that hides in memory and shows you what your serial ports are doing. It's a valuable trouble-shooting utility for pin pointing serial printer and modem problems.

ICON MAKER allows you to generate sophisticated bit- mapped images. Its' easy to use and extremely colourful, producing data that can be incorporated into other programs.

SHELL is another DOS menu program. This one is very fast, free of 'snow', and provides easy access to virtually all DOS features.

STRIKER is an experience. It's a brilliantly written helicopter game in the style of Choplifter, complete with professional high resolution graphics and running spies.

RAMSET is a RAM expansion program from the July 1986 edition of Computing Now!. It allows you exceed the PC's 640K memory limit. Ramset also lets you bypass the PC's time-consuming memory check.

TRAP is the high-resolution Gemini patch program from the May edition of Computing Now!. It makes the Gemini 10x suitable for use with Personal Composer, but is easily modified to fix most bit-mapped printing problems. MASM and Link are required to assemble the program.

$19.95

VOLUME 14

CUT AND PASTE is a memory resident program that allows you to grab text from the screen of any application and paste it into any other application that accepts characters for input.

INT13 will help you unravel the copy protection schemes of your software so you can make archive copies — just in case the cat takes a fancy to your masters. It prints a log of direct disk accesses and where they're called from so you can check out the code that's going after specific tracks, the heart of most protection systems.

PMAP tells you what's living in the memory of your system — and where. It will help you to find the resident utilities you have loaded and, more important, is great for sorting out peculiar interactions between multiple resident programs.

SOFT TOUCH is a keyboard macro program not unlike ProKey. It allows you to store up to twenty five thousand key strokes, has a built in screen blanker and great wandering herds of other features.

SUB CHASE is a first rate graphics arcade game. One sails across the clear blue sea — or green sea, depending on what sort of monitor you have — heaving depth charges off the stern to blow up subs. Requires a colour graphics card.

TheDRAW is an ANSI screen editor. It allows you to create and edit full colour screens of text and graphics which can be displayed from DOS — in full colour — or integrated into programs. Requires DOS two or better, ANSI.SYS and is more fun with a colour monitor.

TREK is the best Star Trek game yet devised for the PC. The graphics are stunning, the complexity is intense and the action scoots along at warp nine as soon as the program gets going. Requires a colour card.

CROSSWORD is a utility which translates text files from one application to another. It supports several popular word processors, including WordStar, WordStar 2000, Multimate, XYwrite, SideKick and standard ASCII.

$19.95

VOLUME 15

ALTAMIRA This is one of the nicest public domain paint box programs available for the PC. It does first rate pictures. Colour graphics card required.

FRACTAL This is the C source code for the fractal generator that first appeared in the August 1986 issue of Computing Now! Requires a C compiler and a colour graphics card.

NEMON This is a really weird game. You get stuck in the catacombs of king Nemon with nothing more than your wits and a flashlight. You have to find some keys, some treasures and, hopefully, a way around a host of arcade game nasties.

THOR used to be the god of thunder. Now he appears to be the world's most sophisticated desk calendar program for keeping track of appointments.

ROUND 42 This is bizarre variation on the theme of space invaders. One of the best computer games in creation. Requires a colour graphics card.

V20 is a CP/M emulator for users of the NEC V20 chip. Replace your existing 8088 with a V20, score this little program and most CP/M software will run on your system as if someone had stolen half the bits out of your PC. Regular MS-DOS isn't affected. Requires a V20 chip.

$19.95

VOLUME 16

ARCDIR The archive file compression system is the most efficient way to store large files in a small space. This simple ARC directory utility was featured in the November 1986 edition of Computing Now!. It includes both a COM file and the source code so you can see how it works. Requires a C compiler if you want to meddle with it.

BRICKS The "Little Brick Out" game is one of the classic programs for microcomputers. This splendid version will get you turned onto simple games all over again.

DX This is a small DX-7 voice librarian, as found in the Book of Computer Music. It includes both a COM file and the assembler source code.

MOREROOM If you have a hard drive system you may have noticed that it's extremely inefficient with small files. Here's a collection of tricks to get substantially more space on your disk.

E88 is a tiny — but powerful — text editor. Neat and compact it is perfect for programming.

EXPERT Commercial Expert Systems software is still in its technological infancy. If you're interested in learning about expert systems and how they relate to your computing needs, you should try this simple program.

FULLDOS A DOS enhancement program that makes the DOS user interface behave in a rather more friendly manner. It creates a command stack and lets you re-execute previous commands.

K9 This is yet another resident keyboard enhancer — with a difference. Aside from expanding the keyboard buffer, installing a screen timeout and so on, it makes a number of the alternate keys 'hot', giving you dozens of unique functions.

InstantMENU This is the code for the Instant Menus article which appeared in the November 1986 Computing Now!. With it, you can create elaborate batch file menus without programming. Menus can be easily altered with a text editor or word processor. Source code is included.

PALERT We've all occasionally run out of disk space while inside an application and discover that we've been dumped back to DOS unexpectedly. This program warns you of an impending full disk.

$19.95

VOLUME 17

ARC512 This is the latest version of the de facto standard PC file compression and archiving utility. It will create, maintain and crack unpack ARC files. See the November 1986 edition of Computing Now! for more about this.

ATC ATC stands for "Air Traffic Controller". In this colourful simulation of the rigors of managing the planes at a busy airport may, among other things, renew your interest in train travel.

DRAW POKER This is a really slick little poker machine simulation. The graphics are good, the play is fast and the machine doesn't always win. It's a shame it won't spew silver dollars out of your disk drives.

HercBIOS This set of routines will allow you to display text on a Hercules card when it's in one of its graphics modes — just as you can with a colour card. It will intercept the 10H interrupt vector so that anything that normally tries to print to the colour card will also work for the Hercules card.

HotDOS If you've ever found yourself wanting to run a second program without quitting your first application, then HotDos was made for you! Hit its control key combination from within most popular programs and it will give you a DOS prompt to run any other program at.

KBD This is a very tiny keyboard buffer extender. It's a useful few bytes to have around, and extremely tiny.

LinkFOUR A simulation of "Connect Four", this is a deceptively simple game. The graphics and sound effects are particularly good.

MONEY Yet another Canadian mortgage program, this easy-to-use program is surprisingly most colourful. It will also calculate charts for a variety of financial situations.

PCWINDOW This is a resident utility which lets you call up a number of useful "windows". These include an elaborate event timer, a note pad, an ASCII code chart and so on. It's well done, fast, and fairly small.

PD This program redirects the output of one's system from the printer port to a disk file. It lets you to use things that normally insist on having a printer on line even if you don't own one, or don't want hard copy.

$19.95

VOLUME 18

BRADFORD A fancy printing program for Epson and Gemini dot-matrix printers.

CARD This is the draw poker machine program from the December 1986 edition of Computing Now!. It's included here both as an executable COM file and as source code in C.

DIVERT This is a tiny program which doubles the effective screen printing speed of most programs which print through DOS.

DONKEY KONG This is a pretty snappy public domain implementation of the classic arcade game. Getting squashed by oil drums is more fun than anything. Requires a colour card.

MASTERKEY is a public domain disk manipulation program that offers track and sector editing, unerasing files, and all the general low level fiddling that the expensive programs do.

PRINTER This is the PRINTER.BAS program from the December 1986 edition of Computing Now!. It reprograms the high end characters of an Epson FX-80 (or compatible) printer to make them print IBM PC screen block graphics.

QUICKEY This little program speeds up keyboard action.

ZOARRE This is another dungeon game, but terrifically well done and very intricate. It displays a picture of the room you're in, zaps you with various monsters and generally tries its very best to kill you. If you liked Castle you'll freak over this one.

$19.95

VOLUME 19

BOTH is a small utility which can slash your paper bill by allowing you to print long files on both sides of the paper.

DIAGS Written by the author of Z80MU, this collection of tools will be nirvana for the experienced PC programmer. It does things like generate an annotated list of all the interrupt vectors in your PC, let you meddle with the 6845 registers, test most of the ins and outs of your system and so on. It's a brilliant bit of work.

GRCP Graphic cut and paste is a memory resident tool that allows you to scoop things from a PC high resolution graphic screen and pop them into other applications.

LOCKERUP This tiny microbe of code sleeps in your system until you have to leave your PC for a while. Then it enables you to irrevocably lock up your keyboard until you come back to restart it. It's perfect for offices where there are more fingers than hands to contain them.

MEGAPEDE Just when you thought that it was safe to play ASCII games again... This one is a sophisticated variation of the classic "snake" programs and it plays with the speed of a boa constrictor. Don't count on winning for a while.

MURPHY Sort of an iconoclast in a can, this program will print a random selection of several hundred of murphy's laws, corollaries and commentaries thereon each time it's run. If you put it in your AUTOEXEC file it will say something clever each time you start your computer.

QUEBERT This fast PC implementation of the classic arcade game is every bit as exciting as the real thing but lacks a coin slot. Jump down the mountain, avoid the snake and try not to get clobbered with fresh fruit. Sounds like real life...

SAT This is a powerful, menu driven satellite data downlink terminal, as discussed in the December 1986 edition of Computing Now!.

SCAV This is a great program for people who buy economical floppy disks and just about everyone else who can't afford a clean room for their PCs. It cruises through one's disks locking out bad sectors and restores previously 'fried' disks to usefulness.

SimCGA The utility does an astoundingly good job of making a Hercules graphics card behave like a colour graphics adapter. It will let you run most CGA software.

STUFFIT Stuffit is a disk management utility which stuffs files into the inner tracks of a floppy disk, allowing the outer tracks to be used for work space. This improves the disk access times and the reliability of mostly full disks considerably.

$19.95

VOLUME 20

ARTIFICIAL ART generates an ever changing graphic image on your PC — with accompanying sound. While it may seem a bit pedestrian, it's a gas to watch. Requires a colour graphics adapter.

AsEasy This is a public domain spreadsheet package, very similar in its abilities to the more popular functions of Lotus 1-2-3. Unlike Lotus, it doesn't cost anything and it isn't copy protected.

ASYNC This is an assembler file which creates a device driver to make the PC's serial ports behave as they should, with interrupt driven buffered inputs and outputs. This is a programmer's delight. Requires MASM to use.

ChessII This is one of the best chess programs yet devised for the PC. Aside from being small and fast, it lets you physically pick up the pieces and move them rather than entering board co-ordinates. Plays an evil game, too.

HAUNT This is a haunted house adventure game. You wander around looking for the mysterious pumpkin man while picking up things, encountering ghosts and, if you're not careful, getting busted for shoplifting.

LPTX The most flexible printer redirection program imaginable, this thing lets you set up virtual printers, that is, disk files to capture the output of things that think they're printing. Includes both executable and source files.

PITFALL This is a supremely clever ASCII game. Aside from being an absolutely superb game in itself, it's a clever use of the PC's screen. You get to pilot a spaceship down a winding, rather nasty pit. More fun than being beamed into a supernova.

RAMDISK Once you've installed a normal RAM disk, it's there for the duration. This one allows you to change the size of the disk on the fly, or blow it away all together, without having to reboot anything.

ZAPDRAW This is the C source code for the Graphics in C article from the January 1986 edition of Computing Now!. It creates a general purpose high speed PC graphics library, suitable for use on both the colour card and the Hercules board. Requires Lattice C or something similar.

$19.95

VOLUME 21

CACHE A disk cache program allows one to vastly speed up the disk access of a PC by stashing frequently used sectors in memory. This public domain cache program is extremely fast and fairly intelligent about which bits of oxide it retains.

COREWARS Perhaps the first program to truly embody the spirit of the phrase "computer game", Corewars pits tow programs against each other. The object of the game is to crash the other code.

EMACS This is the latest word in well-executed programmer's text editors. It has multiple windows, macros and will even create a DOS shell for you so that you can skip out for a while to execute another task. Requires NANSI.SYS (see below).

MTS lets you run two applications, flipping back and forth between them at the stab of a key. This is the first one of these things we've seen that's bug-free.

VIEW This is the fastest full screen file browser in creation. It allows you to page back and forth through a file — it's much slicker than the DOS "TYPE" command. Requires NANSI.SYS (see below).

NANSI.SYS A replacement of ANSI.SYS, the improvements in the performance of your system that NANSI can produce are almost godlike. It includes a high speed screen driver and additional escape sequence screen handlers.

MIDIzap Figuring out the secret codes that drive some of the more sophisticated MIDI instruments is a lot easier if you have something to send and receive them with. This little MIDI debugger runs with the popular ROland MPU-401.

SHELL This is a command.com replacement that implements a UNIX-like environment. It supports many features that DOS would like to have, and a much tighter command structure.

MUSIC SYSTEM This is a pair of programs which allow you to edit and play three voice music on the PC. These programs are not compatible with PC/ATs.

DEV This is a tiny utility that will locate the device drivers in your system's memory. It includes the assembly language source code.

$19.95

VOLUME 22

CALENDAR This program prints up a calendar for any month in the twentieth century. It's very useful if you want to know which days people were being idle on in 1921, for example.

DFA This a a strange disk accelerator program which attempts to anticipate which sectors your software will call for and fetch them when the computer isn't busy. It can speed up some programs quite noticeably.

FSDEBUG lets you scroll forward and backward through a disassembly, set breakpoints, trace code and so on, all with a full screen display.

GRAB.ASM The source code for the graphics grab program from the March 1987 issue of Computing Now! Requires MASM to assemble.

SCROLL This is a resident scroll lock key enhancement. It's not all that exciting, but, then at 247 bytes, it's not all that big either.

SIDEWAYS This program lets you print awkward-sized documents sideways on an Epson printer.

PLAYSONG This is the source code for the linkable interrupt driven music playing package from the March 1987 issue of Computing Now! It also includes the MUSIC.C demonstration program. Requires MASM to assemble and a C compiler to deal with the demo.

ZAPDRAW2 This is the C language source file and updated header file for the text and graphics module from the February 1987 edition of Computing now! It embodies several significant enhancements over the published version, including a writing speed increase of about 10 times. Requires ZAP 1.C from our Volume 20 disk and a C compiler.

PINBALL2 If you wasted a meaningful part of you life on the pinball game on our Volume 7 disk, this one will help you ruin what's left of it. It's the fastest, most colourful, weirdest pinball program to date.

MACSHOW This program allows you to look at Macintosh MacPaint image files on a PC. It will also print them and convert them to PC compatible bit maps. Several sample pictures are included. Requires a colour card.

WILLY THE WORM This is a fast graphic game in which you try to get Willy the Worm home. It's extremely strange.

$19.95

VOLUME 23

ARCE A really tiny archive utility, this thing will extract members from ARC files without tying up half a disk for itself.

BABY An extremely warped game, this thing is engaging and fairly challenging none the less. It involves catching babies who are leaping out of a burning building.

CHMOD This is a useful utility for reading and changing the bits in a DOS mode flag.

CITYDESK This is an elegant fancy printing program that allows you to do some desktop publishing functions with a dot matrix printer.

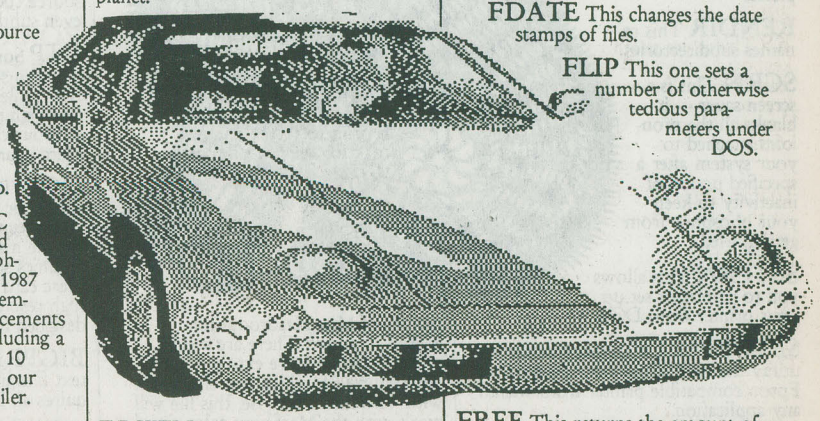
DOG A disk organizer, Dog will defragment the files on your disks to make them quicker to access.

FPR This is a printing program written in C. It's not compiled — you can change it to meet your needs. Requires a C compiler.

THRILL There is little to say about this program. It's a beautiful example of high resolution PC graphics, and was too good to ignore, even if it was wholly useless. It's also a bit naughty.

MIDI-IO This is the source file for the interrupt driven MIDI communication module from the April 1987 edition of Computing Now! Requires MASM to assemble and a language compiler to use — preferably C.

PC-WRITE The latest version of this phenomenal word processor, this thing is enough to turn you off any other word processing package on the planet.



EDWIN This is a decent windowing program editor written in Turbo Pascal. It's not terribly fancy, but it's fast and very much like WordStar.

$29.95 (2 disk set)

VOLUME 24

AC This is a small area code program — give it a three digit area code and it will tell you where it is.

ASC This is a memory resident utility that pops up a window with an ASCII character chart.

ATTR This utility lets you meddle with the attribute bit of your files.

BAC This is a disk backup utility that is much less frightening than the one that comes with DOS.

BACKSCRL This recalls stuff that has scrolled of your screen. It's neat if you can't seem to reach the NumLock key in time.

CAT This is a collection of disk utilities in one program.

CLOCK One of the nicest clocks we've seen, this has a built in alarm function among other things.

COVER This is a sorted disk directory that prints out all the files on a floppy in a form suitable for sticking to the sleeve.

CWEEP This is a menu driven file mover — saves typing the word COPY over and over again.

DDIR Yet another directory utility, this does a two column directory similar to the regular single column DOS version.

DELZ This wipes out files so they can never come back — kills the sectors as well as the directory entry.

DISKCAN This one checks your disks for bad sectors — get 'em before they get you.

DOORS This lets you flip between multiple monitors without rebooting your system.

EQUIP This program tells you what hardware your system thinks it has — often providing you with the answer to many software problems.

FASTDISK If your floppies seem a bit tedious, you might want to zap 'em with this speed up program.

FDATE This changes the date stamps of files.

FLIP This one sets a number of otherwise tedious parameters under DOS.

FREE This returns the amount of free space on a disk without having to watch the whole directory scroll by.

GERM This is a memory resident interrupt driven communications terminal.

IBMSHELL This allows you to fool your system into loading COMMAND.COM from other places.

KBBUFF This is a keyboard buffer extender. No home should be without one.

KEYFAKE This allows you to "stuff" keyboard characters into an application to get past tedious introductory screens and menus.

LC This counts the number of lines in a text file.

LOCATE This scans through subdirectories, checking all the files for specific text strings.

LOCK This is a file encryptor. Also includes UNLOCK.

MOVE This moves files between subdirectories with less typing than COPY would entail.

NDOSEDIT An updated version of regular DOSEDIT, this is a resident DOS command line editor that actually makes DOS decent ot work with. Indispensable.

NO This is a strange little wild card exception thing. It allows you to create more complex file specifications than does DOS all by itself.

NPAD This is a simple memory resident node pad.

PCUTIL This is a collection of add ons to DOS.

PINHEAD This is the printing press program from the June 1987 edition of Computing Now! It can get up to 16 kilobytes of text on one page. Includes the C source code. — works with Epson compatible printers.

POPCAL This is a memory resident utility which will bring up any month of any year you like.

PR This is a handy formatted printing utility.

PUSHDIR Primarily used in batch files, this allows you to change subdirectories, do something and then return to the previous directory.

REBEEP A replacement for PAUSE, this is a noisy batch file utility to attract attention when a task has been completed.

RENDIR This renames subdirectories.

SCRN This is a screen saver — it blanks all the monitors attached to your system after a specified period of inactivity to keep your phosphor from getting fried.

SETPRN This allows you to painlessly set up your printer from DOS.

SETUP This is a memory resident utility that will allow you to set up an Epson compatible printer from within any application.

SIZE This returns the number of allocation clusters a file occupies on the disk.

SOUND This makes weird noises to attract attention from within a batch file.

SP This is a really nice little print spooler.

SWEEP This allows you to execute a 4command in every subdirectory on you r disk.

UNDEL This recovers accidentally deleted files. You man not need it now but you sure will sooner or later.

VDL This requests verification before it deletes files so you won't need UNDEL quite as often.

VOLSER Changes the volume name of a disk.

WAITN This pauses for a specified time while executing a batch file.

WHEREIS This finds files in subdirectories. It includes the C source code from the june 1987 edition of Computing Now!

XDEL This is a menu-driven file deletion utility.

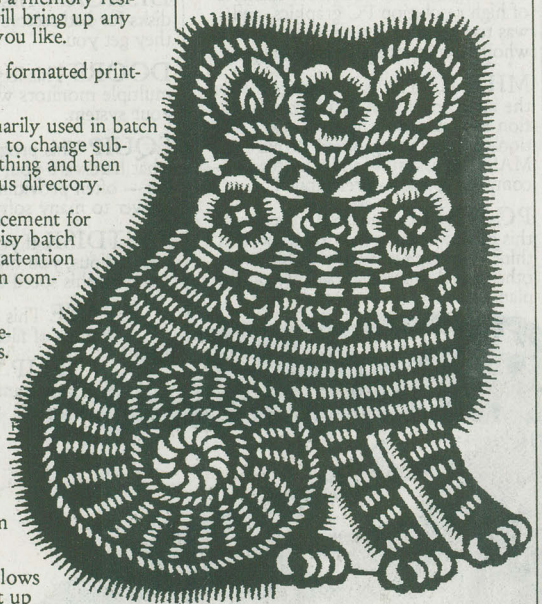
$19.95

VOLUME 25

VMAC4 this little program allows PC users with Hercules compatible cards — or ATI multiple monitor boards — to look at MacPaint pictures. The Herc card has a more usable aspect ratio than the colour card, and the images look pretty slick.

PINBALL3 The weirdest pinball game we've encountered thus far, this thing will zap your brain if you play it late at night.

MAXHEAD This is a MacPaint



picture of Max Headroom for VMAC4, above. There are several more — rather more exotic — pictures on Volume 24, which will also work with VMAC4. Likewise, this file will work with the MacShow colour card program on the disk, which can be used to convert it for use in other PC graphic software.

SPKR A device driver, this little beast allows you to make the PC's speaker play music in a very elegant, program independent way. It's suitable for use with BASIC, C, Turbo Pascal, assembler and even just from DOS.

RESQ can recover erased files and, more important, it can find text that you've lost in memory due to a software crash and get it back into a file. It's indispensable.

IT The "Ideal Terminal" is a telecommunications terminal package which emulates several professional mainframe style hardware terminals. It also handles XMODEM and KERMIT file transfers, making it a much less freaky replacement for the likes of QMODEM and CrossTalk.

RIGHT HAND MAN is a sort of enhanced public domain SideKick. It provides all sorts of pop-up utilities including an ASCII table, a really powerful calculator, a DOS shell and several note pads. It also handles keyboard macros.

SLOWDOWN A lot of software — mostly games — which has been written to run normally on a PC switches into maximum overdrive on an AT or even a fast PC. This usually makes it useless. The slowdown program allows you to bring the speed of such a machine back down to sublight levels for these occasions.

$19.95

VOLUME 26

AWS Programs that turn WordStar into ASCII abound, but this one turns ASCII back into WordStar. Let those high bits roll.

BADCLUST This program finds the bad clusters on cheap disks, preventing them from killing your data. If you must use low rent oxide, use it carefully.

CHEAPFMT Like BADCLUST, above, this program makes your life less freaky if you use cheap disks. It formats them very carefully, looking for unusable sectors.

CCC A C language programmer's dream, this is a "pretty print" program, that actually draws nesting loop and structure diagrams beside the source code it lists. It makes spotting even subtle bugs effortless.

CTP Something of a mutated fusion between snake and space invaders, this is a ruthlessly fast arcade game in first rate high resolution graphics. Requires a colour card or HGC, below, and a Herc board.

HGC This is the first colour card simulator for a Hercules board that really seems to have its act together for the majority of colour card graphics software. Run it and your Herc card will display colour card high resolution graphics as if it was designed for the task.

BIGPRINT This program prints text files in very large characters. It requires an Epson compatible printer.

MBS This is one of the nicer fractal programs we've encountered, as well as being one of the faster ones. It runs on a colour card, or on a Herc board with HGC, above.

MOUSE This is the source code for the linkable MOUSE driver, as seen in the July 1987 edition of Computing Now! It requires MASM to assemble and a C compiler to use.

PCRR This is one of the most interesting programs we've yet encountered. It simulates a railroad in high resolution graphics. You can lay out your railroad, equip it with multiple trains and make the whole party go. Requires a colour card or HGC, above and a Hercules board.

TASKER This is the most elaborate multitasking system yet devised for the PC. Install up to nine variable sized partitions, with a program running in each, and pop between them instantly.

WINDOW This is the source code for the C language window manager from the July 1987 edition of Computing Now! Written in Lattice C.

$19.95

VOLUME 27

DECEIVE This is a resident program to be used if your boss likes to creep up behind you when you're supposed to be working. At the touch of a key your PacMan screen can be replaced by WordStar, Lotus or any other serious application until the powers that be are satisfied and play can resume.

DPATH Allows the opening and creating of files to be handled with a path, just as the running of programs is under DOS with the PATH command. This is the gift of the gods to programs that can't find their overlays and configuration files.

HXC A sophisticated hexidecimal calculator, this program will keep you from damaging your hands by trying to glue on four extra fingers.

IOMON This is a resident utility which monitors the disk I/O of your system and lets you see what the drives are doing. It's great for spotting the causes of system errors.

TREECOPY This is the best... and fastest... tree copy utility we've encountered to date. It will copy an entire subdirectory and all of its included subsubdirectories into another tree.

TREEDEL This program will wipe out a whole subdirectory and any subdirecties in it with one command. Mass slaughter... what fun!

TREESIZE This programtells you how much space is occupied by the aggregate contents of a subdirectory.

VRAM This amazing bit of work is for people with programs that want to see a Lotus-Intel AboveBoard memory card...if they lack one. It allows up to eight megabytes of hard drive space pretending to be extended memory...sort of a reverse RAM drive.

LQPRINT is a nice print enhancement utility that works with many word processors and printers. It includes a wide selection of very well done fonts.

ZANSI Another replacement for ANSI.SYS, this one increases your console printing speed by almost fifty percent without sacrificing any of the commonly used ANSI.SYS functions.

CYLON This makes your cursor go strange... deliberately. Requires an EGA card.

EGAROIDS The best asteroids

game ever written for the PC... when those rocks come at you, pray to the cosmic gods. Requires an EGA card.

KC-PAL An EGA palette editor and librarian. Comes with lots of support utilities and toys. Not surprisingly, it requires an EGA card.

NEWFONT Replace the austere, depressingly corporate IBM font of your PC with damn near anything you can think of. Several fonts are included. The screen interface is seamless, and the results can be extremely pleasing. Requires an EGA card.

$19.95

VOLUME 28

ASTROLAB This is a very sophisticated program for working out the conjunction of the planets for any day in history. It's not much use if you believe in a flat earth, but handy for horoscopes.

BASERES Yet another resident utility, this thing will accept numbers in any base and show them to you in all the other commonly used notations. In other words, it will convert decimal to hex and back again—great for people with only ten fingers.

BREAKON This is a utility to make just about any program exitable with control-break. It has multiple levels of urgency—three hits gets you out of anything short of the end of civilization as we know it. Assembler source included.

CROSSWRD If you've ever wanted to generate your own crossword puzzles, this is the code for you. Fill it full of works and it finds places for them—keeps track of the clues,too.

DIMMER The smallest screen blanker yet—two hundred and seventy one bytes.

EPSONISM Even people with laser printers occasionally have to deal with plebes. This program is a DOS filter to make a PostScript printer behave like an Epson.

FASTBIOS This is a pair of programs which will extend your keyboard buffer—without hanging your system—and increase the speed of your screen dramatically.

FREERAM This will tell you the truth about how much useable memory is available to your programs.

LASERGRID This is a rather good ASCII game. Place your bets and hope the aliens leave you alone.

VMUSIC This is a small three voice music player which handles its scores in BASIC music notation. Comes with several songs, and you can easily create your own tunes with a text editor.

IDCKEYS This is an assembly language program to set up the function key redefinitions under ANSI.SYS. It's great if you like to have keyboard macros under DOS without a keyboard redefinition program installed. Requires an assembler to use.

IDCKILL This will go through an entire hard drive—including all your subdirectories—and kill files that match a given specification. A bit nasty if you use it improperly, but great, say, for snuffing BAK files.

LW86 This is an extensive pop up reference card for assembly language programmers. It includes explanations of the op codes, what the assembler directives do and so on, all at the touch of control shift.

SPACE Find out how much useable space is on your hard drive instantly. Includes assembly language source.

YESNO A really useful thing to create complex interactive batch files, this little program returns an error level code basic on the ASCII value of a key press. Assembly source included.

$19.95

VOLUME 29

INSTACALC is a memory resident spreadsheet. It may not be Lotus or Excel, but it's amazingly powerful considering that it lives in an alternate key combination. Includes a sophisticated macro facility.

ALTER allows you to change the attributes of a file... including the time and the date.

CALENDAR is a sophisticated desk calendar which can be made memory resident if you want it to be. It uses data files which allow you to have it remind you of things.

COVER prints disk directories suitable for sticking into the sleeves of your disks... the nicest such program we've encountered. Requires an Epson compatible printer, patchable with DEBUG for other printers.

DISKLITE is a tiny bit of code which shows you when one of your drives is running. Not much use for floppies, this, but great for RAM disks and AT style internal hard drives.

DISKUTIL is a poor man's Norton utility. It will walk you through simple disk level functions, including FAT table fix ups and file unerasure.

MELT clears the screen,dramatically.

MONSTER a memory resident DOS monitor. Check out what your programs do one INT 21 call at a time.

THEGRIN is the most sophisticated MacPaint picture viewer yet. It allows you to stretch and compress images, zoom in and out and generally, hack their bits to bits. It also prints them.

TMAP is a clever TSR program mapper which is itself memory resident. It's superb for finding gorches caused by interacting resident programs.

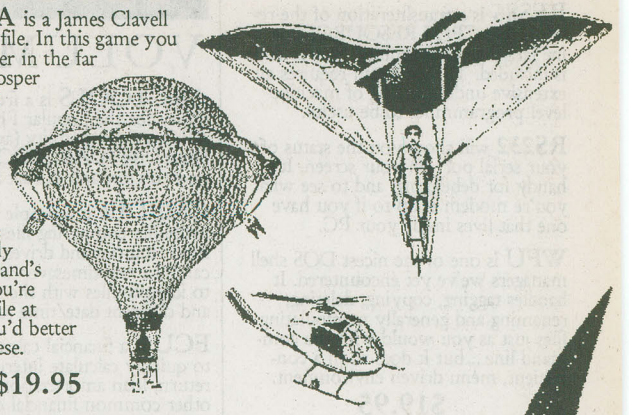
VARISLOW is a variable speed control for AT type computers. It lets you crank the clock down to play games at their normal speeds. However, you can do it interactively, rather than from a command line.

WATERFALL is a fabulous MacPaint picture of an Escher drawing, suitable for use with THEGRIN or any other MacPaint reader.

CHINASEA is a James Clavell novel in a disk file. In this game you get to be a trader in the far east. Try to prosper without getting knifed.

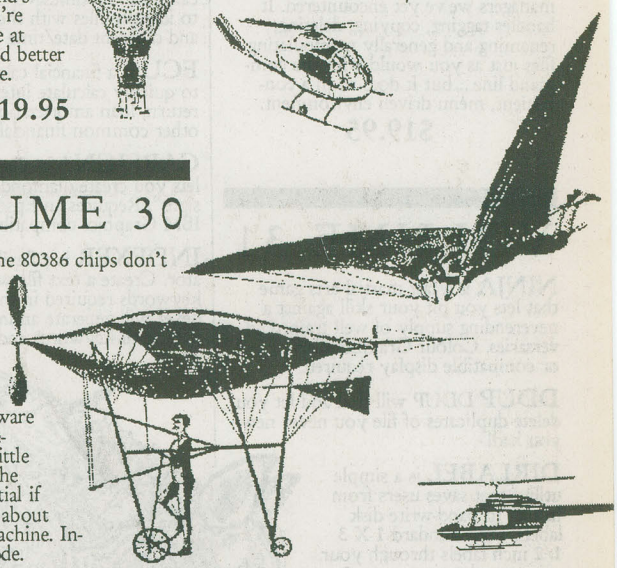
TURBO C PATCHES is a collection of patches to fix some of the bugs in the early releases of Borland's Turbo C. If you're going to compile at warp speed you'd better have one of these.

$19.95



VOLUME 30

386BUG Some 80386 chips don't work quite right. They have problems with integer multiplication, which can cause some software to behave unpredictably. This Little program spots the duds... it's essential if you're thinking about buying a 386 machine. Includes source code.



MASM-MAC This is a collection of MASM assembler macros to make BIOS, DOS and 8087 interfacing a lot easier. Requires MASM to use.

8X6 installs a really tiny screen font on an EGA card. You can get about four times the usual amount of text on your screen with this if you run applications which support it.

AT is a little time bomb program. It will hide in memory and run applications at specific times and dates without any attention. Allows for queuing up several tasks.

BACHMIN is a three part Bach minuet in BASIC... quite the trick.

CAT is a small sorted directory program. While hardly high tech, it is a useful replacement for DIR.

CAVERNS is a fast graphic arcade game. It looks a bit simplistic but it will surprise you when you get into it. Wants a CGA card.

CMOS is a pair of simple programs which read the contents of an AT's CMOS memory into a disk file and then restore it. This is great for changing batteries, of course, and also for those systems with funky memory which require frequent setting up.

DIRNOTES allows you to attach short, one line comments to the directory entries on your disks.

PRTSCEGA is a program to make the PrtSc function work properly for EGA cards, allowing you to once again dump screens to your printer. Versions are included for a stock Epson FX-80 and for the Tandy DMP200. In addition, the source code comes with it, so you can hack a driver up for your specific printer.

EDISK allows you to put a RAM disk in the space between your normal system memory and your screen buffer, using this otherwise wasted space for something practical. It requires that you have memory in there, of course... many RAM cards will do.

EMC is an extended memory cache. It allows you to use LIM memory for a disk cache, speeding up your disk accesses without robbing your system of any main memory.

GDIR is a sorted directory program with uses the Hercules card's graphics mode to put forty-three lines of listings on the tube at once. It's very slick.

HELP is a slick little DOS help program which can be called up any time you need something about the PC explained to you.

THRASHER is a splendid system to find out the optimum setting for the BUFFERS line in your CONFIG.SYS file. It can speed up your disk accesses while actually freeing up a bit of memory.

MCSCOOP is the executable version of the MacPaint file reader in the Jan.1988 edition of Computing Now! It also prints picture files... to PostScript, LaserJet+ and Epson printers.

LDRES is a system to make somewhat standard COM files into memory resident utilities, or TSRs. Please note that while full documentation is included with this thing, it's still a bit technical and you'll have to be a moderately decent hacker to make something come of it.

NOREBOOT will disable the Ctrl-Alt-Del reboot of your system. Source code is included.

RES86 is a transliteration of the redoubtable CP/M RESOURCE machine language disassembler. Source code is included. This program requires an extensive understanding of machine level programming to be useful.

RS232 will show you the status of your serial port on your screen. It's handy for debugging, and to see what you're modem is up to if you have one that lives inside your PC.

WFU is one of the nicest DOS shell managers we've yet encountered. It handles tagging, copying, deleting, renaming and generally manipulating files just as you would with the command line... but it does so in a convenient, menu driven environment.

$19.95

VOLUME 31

NINJA is a fast martial arts game that lets you pit your skill against a neverending supply of well trained adversaries. Colour Graphics Card, EGA or compatible display required.

DDUP DDUP will find and let you delete duplicates of file you never new you had!

DIRLABEL is a simple utility that saves users from having to hand-write disk labels. Feed standard 1 X 3 1/2 inch labels through your printer and start DIRLABELing your floppies.

MADNESS If you thought you were going crazy, you haven't played Madness. MADNESS is an adventure game for the mind. Enter a land of shadows and mirrors, where reality is little more than a hazy concept.

PM is a handy co-resident phone message utility. Just pop PM onto your screen and enter the particulars of each call. PM inserts the correct date and time and appends each message to an ASCII text file that can be printed later.

RUSHHR is one of the strangest games ever created. Play traffic computer by juggling the timing of a series of traffic lights in a busy downtown core. You control the number of cars that are able to get through each light.

SPEED performs a detailed system speed test - similar to the "SI " test provided on the Norton Utilities, only better. SPEED shows you speed statistics for a host of register and memory operations such as arithmetic calculations and block memory reads and writes.

FREECELL This is an unusual solitaire game. Great graphics!

HDSENTRY is a resident utility that intercepts destructive calls to hard drives. Run HDSENTRY before trying out public domain software of dubious origin. It tries to prevent Trojan software from destroying the data on your hard drive.

$19.95

VOLUME 32

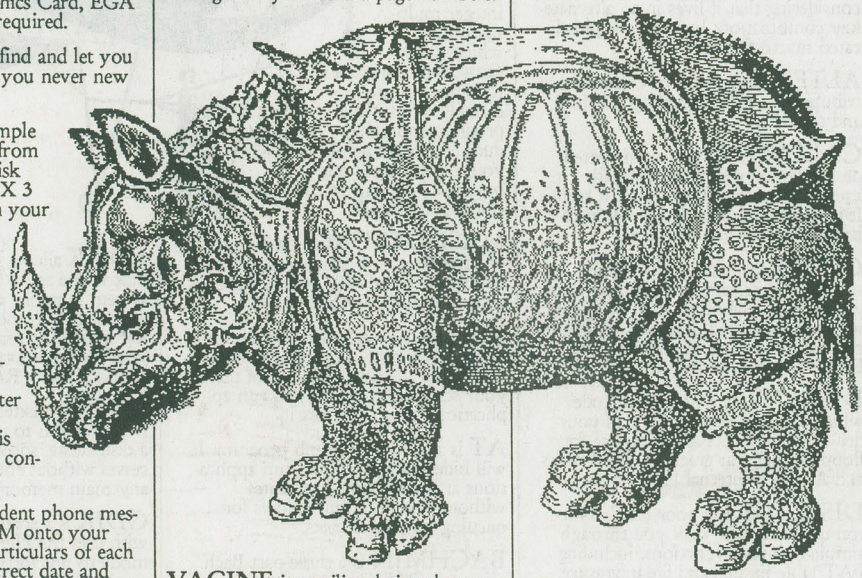
ARCTOOLS is a front-end menu utility for the popular PKXARC/PKARC archiving utility (available on SuperDisk 1). ARCTOOLS makes it easy to view and extract archived files.

CMPDIR is a simple utility that simplifies comparing files in different subdirectories and drives. CMPDIR can be a real timesaver when you need to identify files with the same name and different date/time stamps.

FCU is a financial calculator. Use it to quickly calculate interest, rates of return, loan amortizations and many other common financial calculations.

CARSIGN is a silly program that lets you create diamond-shaped "carsigns". Requires an Epson FX/MX or IBM Graphics compatible printer.

INDEXER is a flexible index generator. Create a text file with all keywords required in the index and indexer will generate an index file containing all keywords and page numbers.



VACINE is a utility designed to prevent "virus "software from infecting you hard drive and DOS disks. VACINE can tell you if the COMMAND.COM and DOS system files have been tampered with.

FREE is a memory utility which reports on how much RAM is available in your system. This one also reports on Extended Memory (above 1024K).

PRUFREAD is a specialized file browser designed to speed proofreading. A highlighted bar remains stationary in the middle of the text screen, making it easy to focus on one line at a time in the text.

FKEYMAP is a utility for printing Function Key templates (for keyboards with function keys vertically oriented on the left-hand side) Great for new users. FKEYMAP includes templates for Word Perfect and Lotus 1-2-3 version 1A.

APRIL is one of the strangest "April Fools" software pranks ever created. Slip it into a friend's AUTOEXEC.BAT file and see what happens. Completely harmless fun. Colour graphics card required. Also works with SIMCGA CGA simulation utility.

DVICEMAP is the most comprehensive utility yet devised to map memory locations of DOS system devices. This one also shows the order in which devices have been loaded, attribute words and interrupt locations.

$19.95

VOLUME 33

READRITE is a co-resident "readability checker". Based on a formula developed by Rudolph Flesch, READRITE can be called up to analyze text. It will provide a readability index that relates syllables per word and words per sentence.

SPACEWAR is a fantastic space battle simulation. It comes in both CGA and Hercules versions and has stunning graphics and fast play. Loads of options!

MFRACT is a simple fractal generator that can display an endless variety of "mountain" fractals. CGA required.

MRORGAN is an unusual co-resident utility that turns your keyboard into a mini organ. It will really jazz up your favourite word processor. Great for office concerts!

FREEBYTE is a small and fast utility that tells you how much free space remains on your hard drives. Yes *drives*. It's smart enough to check space on large capacity drives with multiple partitions.

CHESS2 is a chess game that works with Microsoft Windows (version 2). Great graphics, but it's for two players only. MS Windows required.

DIGICLOK is a handy digital clock for Microsoft Window (version 2). Windows required.

FREEEMM is a Windows utility that shows the amount of Expanded RAM installed in your system. It will also show you how much RAM is left for applications. Requires Windows.

DBWP is a dBase III to Word Perfect Mail Merge conversion program. It can be a real time saver.

TCKILL is a file deletion program with a twist. After files have been OK'ed for deletion TCKILL will toss them into the trash!

TETRIS is a wonderful game! This is the original version that was created in Russia. It is best described as an "action puzzle" and it will challenge your imagination and your reflexes for hours at a time.

TOGGLE is a useful little utility that lets you control the status of your keyboards NUMLOCK, CAPS LOCK and SCROLL LOCK keys from DOS.

STOPCLOK is a handy little stopwatch that prints a huge digital display one your screen. Just the thing for the office olympics or for the occasional impromptu benchmark.

LIFE is a new version of a classic computer game. This one comes with complete on-line instructions and includes a detailed history of the game.

BUFFIT is a nice DOS buffer utility that lets you scroll through DOS screens that have disappeared from view.

ELTYPE is a simple typing test program for training and evaluating keyboard virtuosos. It provides real-time statistics on speed and accuracy.

$19.95

VOLUME 34

DA is a multi-featured directory sorting utility that allows you to arrange DOS "dir" file listings in any order you please...program files at the top, data files at the bottom, yogourt on top, fruit on the bottom, you name it.

IAU is a invaluable hard-disk *I*nterleave *A*djustment *U*tility. It allows you to reset the "interleave" value of your disk, *without* distrurbing your data. If your drive was set up by uncaring, unfeeling mechanics at the dealership, chances are you can double its response speed.

HDTEST is a *very* complete hard disk testing system. It writes and reads several types of test patterns on every sector of your drive, and will find subtle data weaknesses to faint for DOS to notice, Data is removed from suspect sectors, and the sectors marked as bad, soDOS will avoid them in future.

G uses a little data file to store "nicknames" for commonly-used directory paths. By running G followed by the nickname, you can immediately switch to the desired directory — no matter how distant it may be in terms of DOS path specs.

FLUSHOT is one of the most respected anti-viral protection systems ever devised. The program provides checksum protection of system files, immediate warning of any programs that try to leave portions of themselves behind in memory, and warnings any time a program attempts to do direct writing to your hard disk. There are numerous other options, plus very extensive documentation.

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VOLUME 35

SCANNER is a goldmine of information for anyone interested in broadcasts you can't get on an AM/FM Walkman. SCANNER provides Canadian, American and world-wide (where applicable) frequencies for aviation, marine, NASA, news, weather, railroad, taxi and myriad other services.

BCALC41 is a Big CALCulator which will delight anyone who requires miles of precision for their calculations. BCALC41 can calculate pi (or any figure) up to 1075 digits with blinding speed, emulates a Hewlett-Packard calculator with numerous functions, ten memory and four stack registers, and is accompanied by its C source code.

CWCis a remarkably thorough crossword puzzle designing tool whose output actually looks like a crossword puzzle, clues and all. Save and load your puzzles to disk, and edit or print them out at your leisure. Fair warning: the demo puzzle's a killer. Needs an Epson-compatible printer, but any video card will do.

FORMATQM is a practical ... and speedy ... solution to the nightmare of formatting an entire box of diskettes. FORMATQM easily handles all IBM PC and PS/2 disk formats. Though designed to format many disks in one sitting, it can format a lone 360K data disk in 41 seconds flat.

ANADISK is a comprehensive floppy disk aid which, among other things, will copy most disks DISKCOPY has problems with, allows editing of sectors or files in hexadecimal or text, and will endeavor to fix corrupted FATs and remap bad disk sectors. ANADISK reads most combinations of IBM disk formats, and can even read Atari ST 3.5" diskettes (this assumes you have an AT with a 3.5" drive) ...

UNERASER will resurrect accidentally erased files, providing they haven't been written over by other data. This small but vital program is extremely handy should you DEL one file too many.

$19.95

VOLUME 36

FINANCE1 was written to keep track of the home chequing account, and allows both known and estimated (what if?) entries. Charts may optionally be generated of annual income and expenditures.

FORM275 uses IBM's graphics characters and comprehensive editing functions to make designing forms as easy as drawing them on the screen. It comes in handy for drawing street maps and decorative borders, too. Forms may be printed on printers which have the IBM graphics set in ROM, or saved for importing into database programs.

TELEPORTis a snazzy bit of RAM-resident coding which enables you to capture, edit, merge and save up to four text windows simultaneously with a monochrome, CGA or EGA card.

ONSIDE will take spreadsheets saved in ASCII format and print them sideways on an Epson-compatible printer. While that's not an original concept, ONSIDE allows you to choose from seven inherent fonts, which may be magnified in two directions. You may also elect to modify the available fonts or fashion your own. ONSIDE can print lengthy sheets, and will use either a monochrome or colour video card.

WS161 actually isn't another WordStar upgrade, but an exercise in surviving in the wild. Find food and shelter in a forest that has little interest in your leaving it alive. CGA card required. Surprisingly addictive, it beats blasting acquaintances with paintballs anyday.

$19.95

VOLUME 37

OPTIKS is a welcome solution to the amazing proliferation of varied ... and incompatible ... graphics formats vying to become the de facto standard. OPTIKS can read and display .RLE, .GIF, .MAC, .PIC and a host of other graphics files. Once loaded, these files may be manipulated in every conceivable fashion. OPTIKS accepts images from some scanners, outputs to laser and dot-matrix printers and supports EMS memory, VGA, EGA, CGA and Hercules cards.

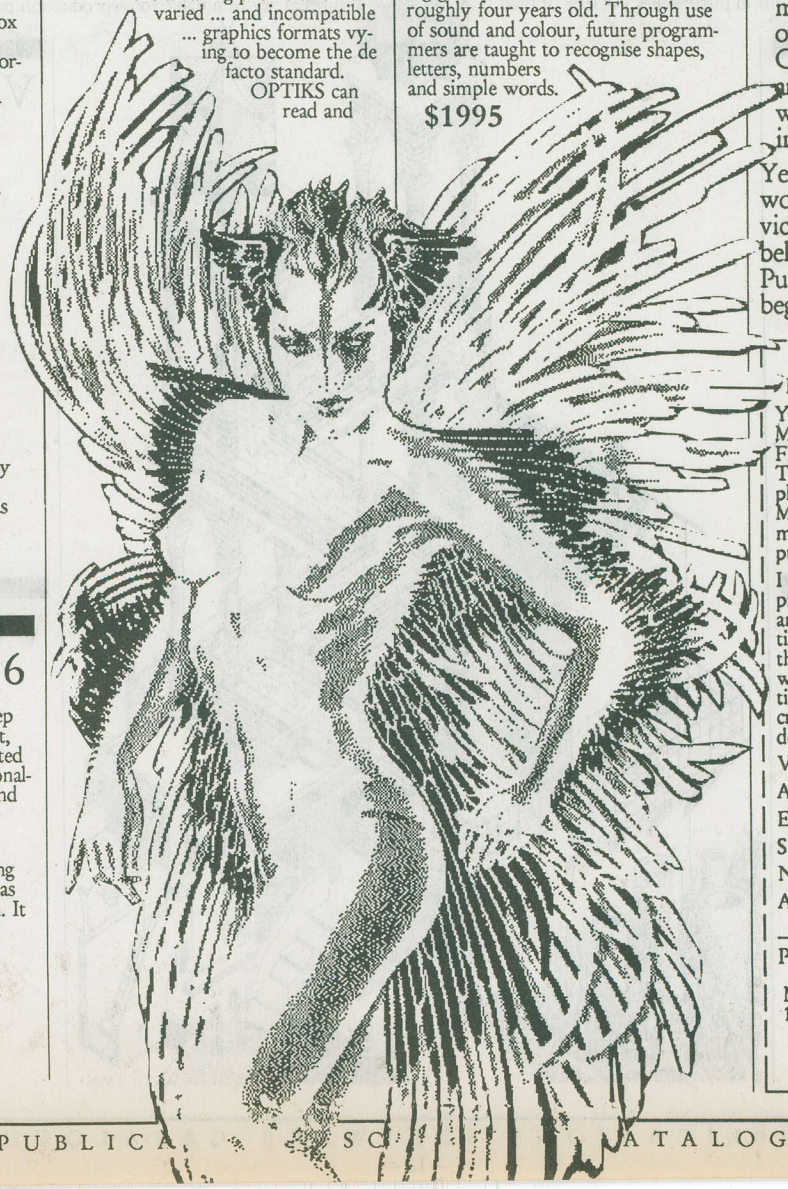
M2COM is a short program that turns readmac files into .COM files, thus eliminating the need for separate display programs. M2COM leaves the original readmac as is, and produces a .COM file of the same length.

GARFIELD is a fat, bug-eyed cat who, in this readmac graphic file, has no respect for computers. Aside from being cute, GARFIELD will give you something to read into OPTIKS and M2COM.

MAHJONG hails from Australia, though the game's roots are in China. Professionally implemented with three levels of play, its graphics alone will entice the uninitiated. Experienced players will appreciate never again losing a tile after a particularly frenzied game. Requires a colour graphics adaptor, though a colour monitor is optional.

PLAYLRN is a collection of learning games for toddlers 18 months to roughly four years old. Through use of sound and colour, future programmers are taught to recognise shapes, letters, numbers and simple words.

$1995



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Our Almost Free Business Package will add power and versatility to your business applications.

MA.BAS The Micro Accountant is a complete, working accounting and check register program, with a 25K documentation file. Requires BASIC.

PCWNDW22 A "Sidekick"-like co-resident window utility. Pop-up window functions include ASCII table, stopwatch, alarm, printer setup utility and notepad.

PSHIFT A time saving and convenient 'memory partition' utility. Lets you define up to nine memory areas. Load programs such as dBase II and WordStar into separate partitions and 'flip' between them instantly with simple keystrokes.

PC-TOUCH.BAS Increase typing speed and accuracy with this easy-to-use typing tutor. Requires GWBASIC.

PCYEARBK Appointments and reminder program to help you keep track of your time.

TASKPLAN.BAS Project management software which lets you track up to 50 tasks during 50 time periods (days, weeks or months). Requires GWBASIC.

NOCOLOR A handy little utility for users with monochrome monitors and colour software.

MAXIT A simple but subtle game for two human opponents, or one player and the computer. Hours of fun!

PERTCHT A sophisticated project management tool using the Program Evaluation Review Technique.

PLUS More utilities to help organize maintain and copy your files, including a "monitor saving" program which blanks out your screen when it is not in use.

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HD SURVIVAL KIT

If you have a hard drive you can have all sorts of powerful utilities and programs installed in your system to make your use of it more efficient and productive. We've collected the best of these utilities on a single disk to help new PC users get the most from their hard drive systems. Please note that these programs are included in our other almost free software disks. Descriptions of them are provided elsewhere in this catalog.

HGC	Colour card emulatorfor Hercules
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WHEREIS	Hard drive file finder
SIZE	File size finder
SETUP	Resident Epson printer setup
RENDIR	Sub-directory renamer
POPCAL	Resident perpetual calendar
CLOCK	Screen clock
EDWIN	WordStar like editor
NANSI	Screen driver
CACHE	Disk cache
RAMDISK	RAM disk program
LPTX	Printer redirection
MURPHY	Foolishness and wisdom
LOCKERUP	Security system
BOTH	Printer paper saver
PCWINDOW	Resident grab bag
PINPRESS	Prints things very small
NOTEPAD	Resident notepad
FREE	Free space finder
HOTDOS	Multiple tasker
BLANK	Screen blanker
K9	Another resident grab bag
LAZY	Menu generator
UNWS	WordStar converter
MORTGAGE	Measure of your indenture
LOOK	File viewer
PCBW	Colour killer
VTREE	Hard disk map
VFILER	File manager
POPCALC	Resident calculator
DOSEDIT	Command line editor

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If you have begun using the popular Ventura desktop publishing software package, you'll know how much graphics can dress up your documents. However, unless you have a scanner and a ready source of hard copy clip art at your disposal.. or a paint box program and a great deal of time... it's very nearly impossible to find spot illustrations in picture files. At least, it used to be Almost free Ventura clip art picture collections are disks full of image files. They will work with Ventura 1.1, and we include a utility to make them suitable for use with the original 1.1 release or the patched one. Each disk has a variety of pictures, both for spot illustrations and full page pictures. They're suitable for reproduction on any output device. Only $19.95

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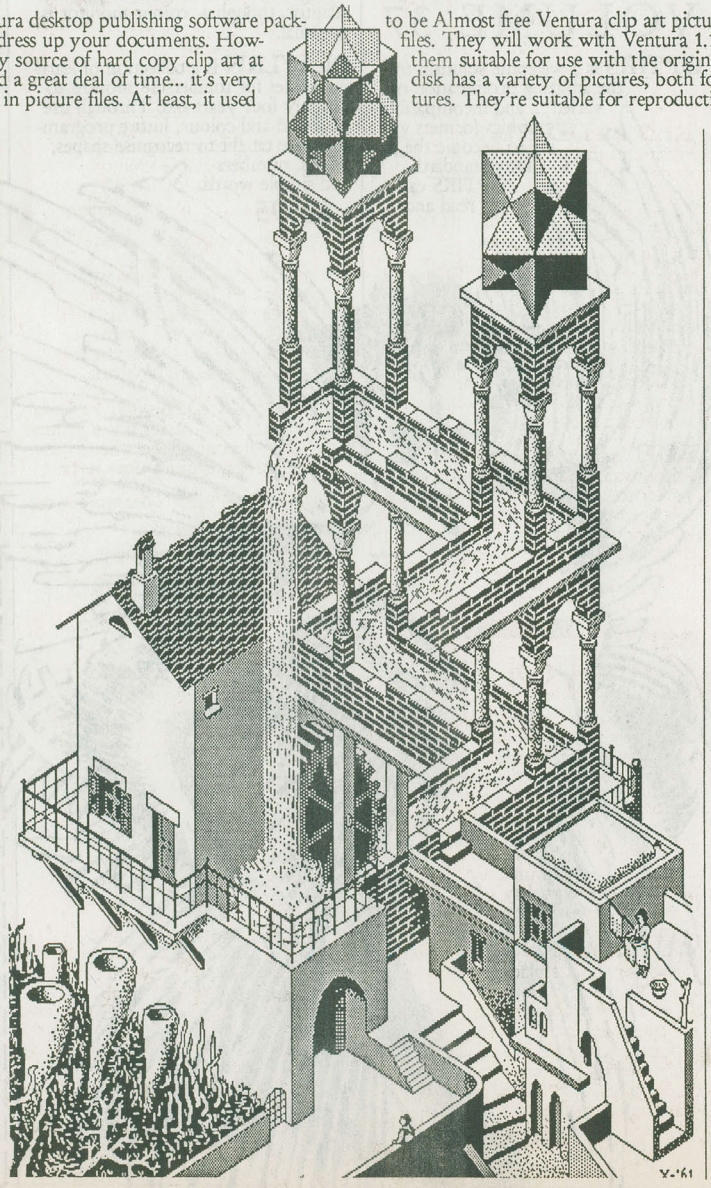

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MAC VOLUME 1

ASTEROIDS This is a splendid implementation of one of the most popular arcade games of all time. The graphics and sound effects are amazing.

RED RYDER Telecommunication on the Mac has never been this easy. Includes XMODEM and Kermit protocols and many other features.

BINHEX is a utility for RED RYDER which converts applications files to binary files and back again to allow transfer over phone lines.

LIFE is a classic computer program; this version is exceedingly well done.

VIEW PAINT Ever wanted to look at a MacPaint drawing without getting into MacPAint. This utility lets you sneak peeks at your drawing files.

MacCLONE Many users have found the Mac's disk copy routine to be less than perfect. This is a vast improvement. It even defeats a number of copy protection schemes.

RESOURCE EDITOR Macintosh icons and other resource items just cry out to be personalized. This little tool will help you make your Mac look its best for you.

SCREEN MAKER Moving text from MacWrite to MacPaint can be a bit disappointing... something gets lost in the clipboard. This utility helps your words make the trip unscathed.

FONT EDITOR For those longing to make their own fonts... and for those who just want to adjust the ones they have... this editor lets you shuffle fat bits to your heart's content.

MENU EDITOR A handy utility for editing the words in Macintosh application menus.

$24.95

MAC VOLUME 2

FONT LIBRARIAN A splendid alternative to the Macintosh system font mover, this utility makes it easy to create custom collections of Macintosh fonts.

WIZARD'S FIRE This is a lively game which comes with still more lively games tucked away inside.

SWITCHER Multitasking on a Mac? Why not. SWITCHER lets you run up to four applications concurrently on a 512K 'Fat Mac'.

RAMSTART Creates a RAM disk of any size on a fat MAc, and effectively increases the speed of most applications several times over.

MADONNA A MacPAint picture of the popular pop star.

MOCK CHART A desk accessory to handle the creation and printing of small business charts.

DAM A *D*esk *A*ccessory *M*anager for setting up the Apple menu on your Macintosh the way *you* want it.

MOCK TERMINAL A desk accessory for telecommunication functions from *within* another application.

HP CALC Add a simulated Hewlett-Packard calculator to your Mac.

REdit A slick resource editor. See the December 1985 issue of Computing Now! for an in depth look.

ORION This one alone is worth the price of the disk. It simulates a star ship cruising around the galaxy at the speed of light. Stars fly past like white lines on the highway. The heavens are accurately mapped and the ship handles like any other warp driven Chevy.

$24.99

MAC VOLUME 3

ICON COLLECTOR is a peculiar program that allows you to locate icons in applications and capture them to disk for use in other programs.

BILLIARD PARLOR is worth the cost of this disk all by itself. It's an excellent simulation of a billiard table. It will play most of the usual variations of pool and billiards, and simulates the movement of the balls with unspeakable realism.

MANDELZOOM is the nicest Macintosh fractal generator we've come across. It's surprisingly fast, considering the nature of the Mac's floating point library.

RED RYDER This is the latest version of this popular communications program. It runs perfectly, giving you a sophisticated terminal with download facilities, macros and dozens of other features.

PACKIT — not to be confused with PackIt will compress and uncompress P2T libraries which have been downloaded from bulletin boards. An essential utility for telecommunications.

BINHEX5 is a file manipulation utility which allows Mac files to be sent over a modem.

EDIT is the most sophisticated text editor available for the Mac. Operating similar to MacWrite, it allows you to edit documents in multiple windows. Ideal for program editing, it produces clean text files which can be compiled.

$24.95

MAC VOLUME 4

One of the most interesting aspects of the Macintosh is its ability to use software-based character sets. While there are a number of commercial font packages for the Mac, we feel that this collection of public domain fonts ranks among the best.

This disk is filled — to the last byte — with thirty-eight unique fonts. We've selected a variety of body copy and display typefaces, spanning traditional and avant garde designs, along with a number of special purpose sets. Bid fairwell to the placid exterior of Chicago, the mild amusement of Geneva, the unadventurous disposition of Athens and plug your Mac into this typesetter's pipe dream.

A powerful font librarian is also included to assist in adding the fonts you want to your system.

$24.95

MAC VOLUME 5

The Apple Macintosh has available for it a whole universe of exciting public domain stuff. Aside from just software there are font files, desk accessories, music files, init resources, paint files and buckets of other things. In this collection we've tried to really overfill a disk with bits. All of this software has been compressed into PIT files to allow us to get more things on the disk, and it fills all but about thirty two kilobytes of a standard eight hundred kilobytes double sided floppy. The PackIt extraction utility is included, and is very easy to use. Software has been tested on an enhanced Mac with one hundred and twenty eight kilobyte ROMs, a megabyte of memory and a Rodime hard drive. Some older Macintosh systems may have trouble with some of these files, particularly the hundred and twenty eight kilobyte "thin" Mac, which will not be able to use some of the software, the INIT resources and a minority of the desk accessories.

APPLICATIONS

AutoBlack a screen blanker INIT resource. Simply put it in your Finder folder or in the root of your disk and reboot your system. It blanks your screen after a period of inactivity.

Bounce Me is a bouncing ball demo, a la Amiga. God knows what it's good for, but it's awfully fun to watch.

Brickles Little brick out in style.

Clim An MS-DOS/unix style command line interpreter, replacing the mouse, icons and finder. Includes batch files and lost of commands... good for program development or when you get sick of rodentia.

Cursor Wrap An INIT resource that makes your cursor travel around the back of your screen when you reach an edge. Quite a time saver.

FaceLift Globally reformat the text in MacWrite files.

Font DA/Mover Install and remove fonts and desk accessories in your System file. Works with all the fonts and accessories in this collection.

Global Search Find files anywhere on a hard drive using the HFS file system.

Jclock This is an INIT resource which puts a clock up in the right corner of your screen. **IconEdit** is the source code for the Pascal program in the December 1987 edition of Computing Now!.

MicroFinder A very tiny... and fast... Finder replacement. No bells, no whistles, just blinding speed.

RDecompiler Decompile the resources in existing applications down to source code and use them in your own programs. Works on about three quarters of all applications. Great little icon swiper.

Screen Maker Converts a MacPaint file to a StartupScreen to replace the boot message of your Mac. Consider being welcomed by the leather goddess of phobos each morning.

Sequencer Batch processing for the Mac.

Set File Change the attributes of any file on your disks. Includes, type, creator and all the bit flags.

Sampler Try out desk accessories without having to install them. Works with all the desk accessories in this collection.

DESK ACCESSORIES

3DTTT A three dimensional tic tac toe game.

Clicker A desk accessory which computers mouse offsets and co- ordinates. Great for precision rodent displacement.

Sleep A manual screen blanker and tube saver.

Camera A screen capture utility with a timer. Quite useful.

Change font Change the system font on the fly from within an application.

Choose Scrap Use multiple scrap books, selectable from within an application.

ConCode A big 68000 machine language help screen system.

DAFont Shows you what fonts and desk accessories are in your system and how they use memory.

Flow An unspeakably weird way to end a Mac session.

IconMaker Capture any chunk of screen and make it into an icon.

miniDOS This should be on every disk in the land. Rename and delete files from within an application.

Other Run desk accessories not installed in your system from within an application. Sort of a desk accessory version of the sampler.

Push Another strange screen killer, like flow.

Set Sound Control the speaker.

VT52 A faithful VT52 terminal emulation to allow calling remote computers from within a Mac application.

MACPAINT FILES

Pictures include: Aircraft • Blues Brothers • Car Logos • • Escher Waterfall • Leather Goddess of Phobos • Pascale • Cars • The Letter A • Zebra girl (some files contain nude images)

MUSIC

Songs include: Sheep look up • Three part invention in G minor • Allemand • Almost persuaded •Brandenburg concertos three and five •Gigue •Malaguena • March in G • Messiah overture • Minuette • Mozart's clarinet concerto • Perludium • Polonaise • Sinfonia • Study • Amen chorus • plus several studies and inventions of dubious origins. (includes Juke-Box music playing software)

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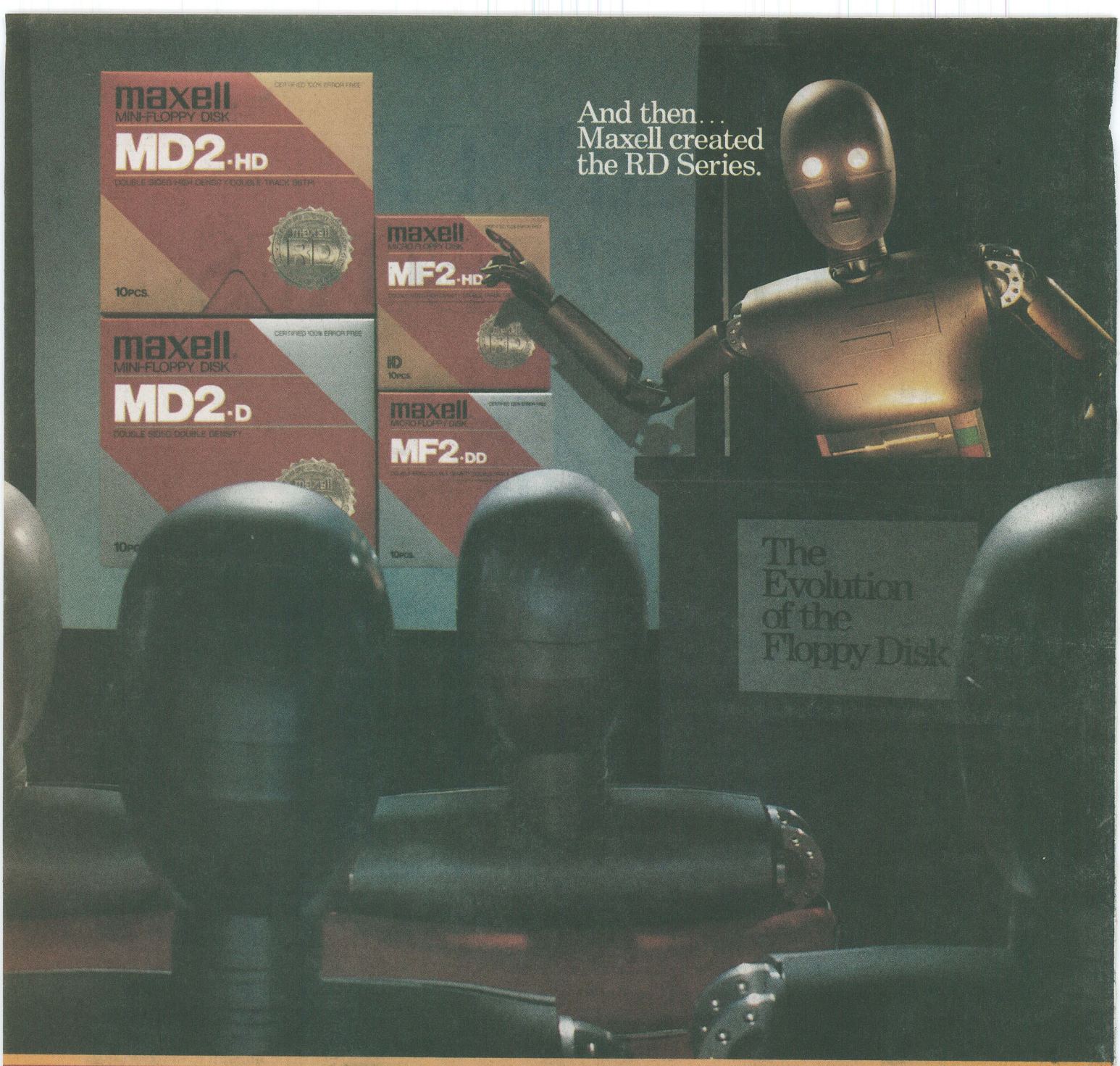

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The positioning of the VCF components on the printed circuit board is shown in Fig. 2. It is optional whether the outputs are taken via the potentiometers. They could equally well be switched to further circuits or equipment.

Tone Equalizing

With the wiring shown the outputs are taken to a mixer stage. This is identical to that used for the Hex VCO and the configuration becomes the Tone Control/Equalizer shown in Fig. 3.

By varying the signal level passed to the mixer inputs, the output will consist only of those frequency bands selected in conjunction with VR6. Between them the four controls allow the VCF to be used as a powerful frequency correction tool.

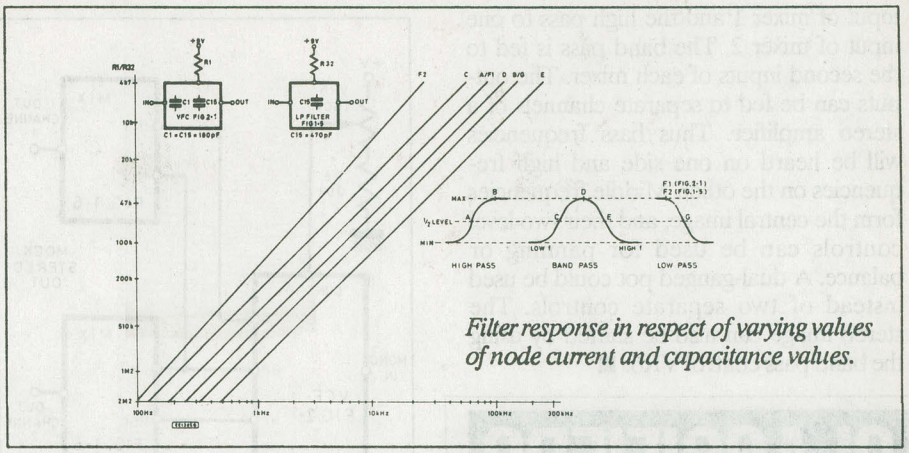
One useful side effect of this setup is that notch filtering can be introduced. This results in the ability to extract frequencies in a narrow middle range by only using the low pass and high pass regions. The positioning of the notch is variable by adjusting VR6. Several VCFs may be coupled for increased filtering.

Another use of a VCF comes from its ability to change the characteristics of a signal by emphasizing its upper harmonics. The basic or fundamental frequency can be tuned out, leaving only a selected harmonic. As any synthesizer owner will know, this can dramatically change the nature of the sound. This can also be shown by feeding the non-sinusoidal outputs of the VCO into the VCF and experimenting with different settings of the controls.

The effect can be further enhanced by coupling the control nodes of both a VCO and VCF so that they track in unison. An obvious control source is to use the voltage output of a synthesizer to produce total and harmonic manipulation.

Mock Stereo

An interesting effect can be produced by feeding the VCF to two mixers, as in Fig. 4. This results in a mono signal being spilt into a simple stereo simulation. Only two of the inputs on each of the mixers are used. The low pass output goes to one



Filter response in respect of varying values of node current and capacitance values.

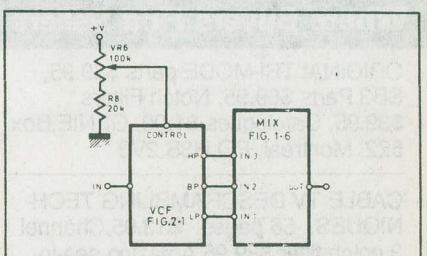


Fig. 3. Block diagram showing the arrangement for a tone control/equalizer.

PARTS LIST

Resistors
All 1/4W, 5%
R1,39,40 10k
R3,4,34,35 1k
R8 20k
R11,14,16, 20-22,
41,45-49 100k
R28,29 4k7

Potentiometers
VR1 100k trim
VR6 100k linear
VR8-10 100k audio

Capacitors
C1,15 180p
C2,3,7,10,
16,19-22 1u 63V
C11 22u 16V
C23 100n

Semiconductors
IC1 LM13600 transconductance op amp
IC2 TL082 dual BiFET op amp

Miscellaneous
PCB, IC sockets, 4 knobs

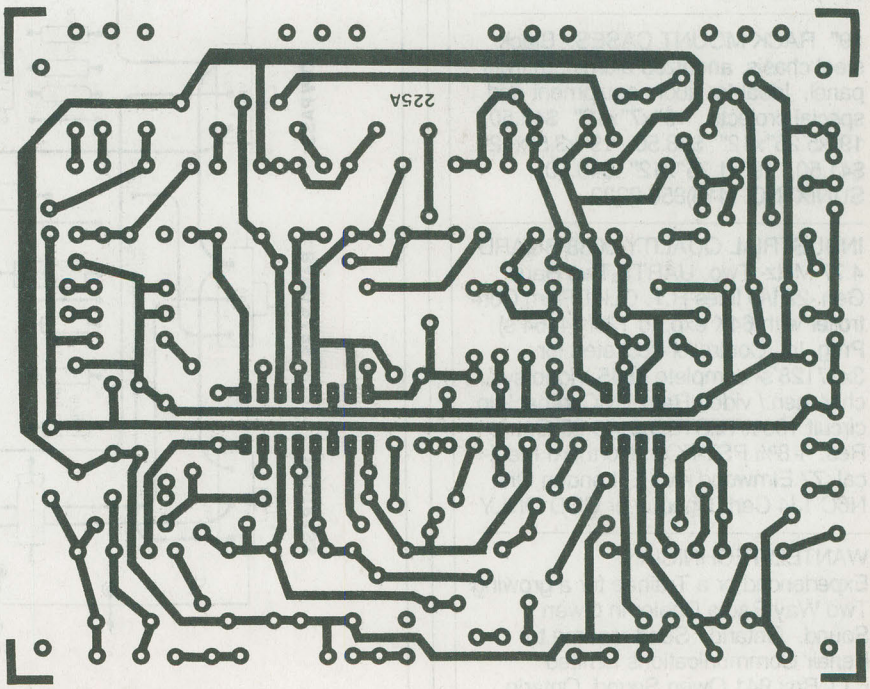


Fig. 2. Printed circuit board component layout for the VCF and mixer.

input of mixer 1 and the high pass to one input of mixer 2. The band pass is fed to the second inputs of each mixer. The outputs can be fed to separate channels of a stereo amplifier. Thus bass frequencies will be heard on one side and high frequencies on the other. Middle frequencies form the central image, and their two level controls can be used for panning or balance. A dual-ganged pot could be used instead of two separate controls. The stereo image can also be shifted by using the band pass control VR6. ■

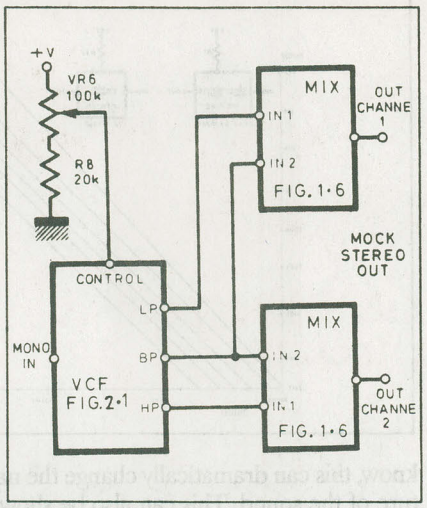


Fig. 4. Arrangement for producing mock stereo. The bass frequencies will be heard from one side and the treble frequencies from the other.

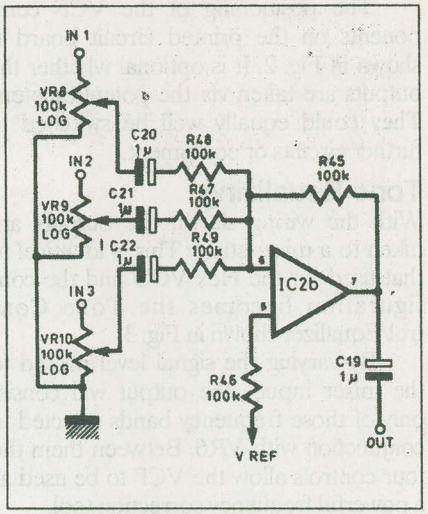


Fig. 5. Circuit diagram for for a three-input mixer.

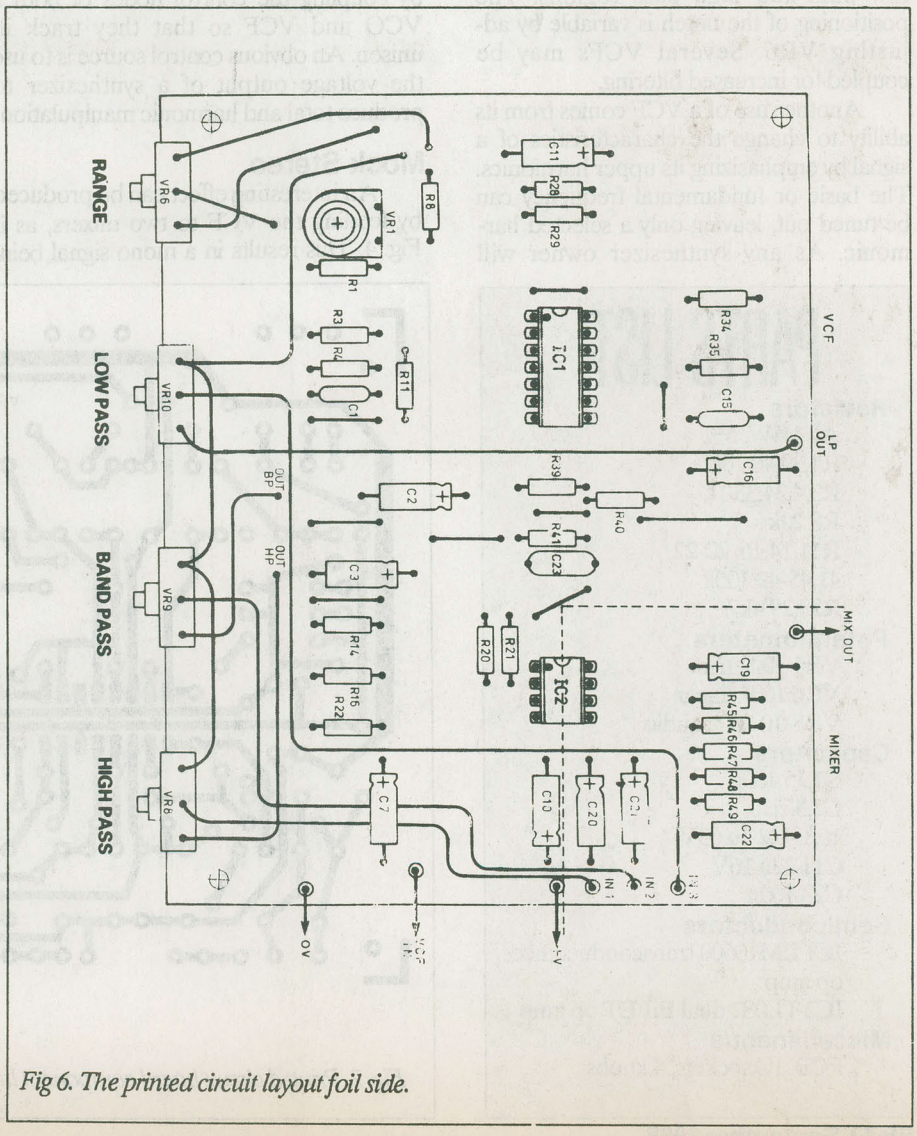
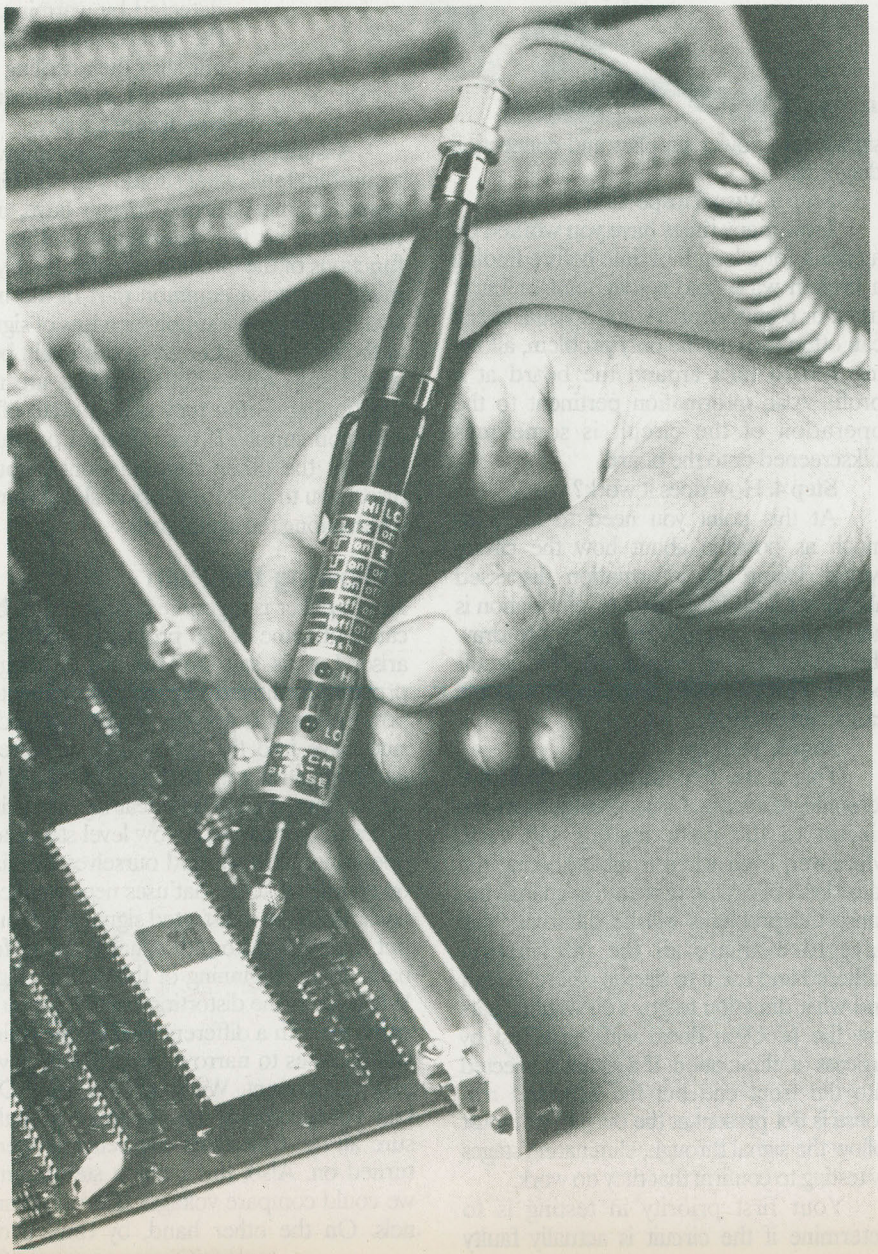


Fig 6. The printed circuit layout foil side.

Troubleshooting Concepts

An eight-step philosophy for effective repair techniques.

RON C. JOHNSON, C.E.T.



Whether you are a hobbyist, technician, technologist or engineer, at some point in time you will have to dig into a circuit and drag out one or more of those gremlins that are obstructing its proper operation. This is not news. What may be helpful, however, is an examination of some practical concepts relating to troubleshooting. The following may not provide all the answers, but it might help you to ask the right questions.

The Inevitable Definition

Contrary to popular belief, a vast knowledge of electronic theory does not ensure good troubleshooting ability. It's true that someone who understands the operation of a particular circuit or system should be more capable of tracing a problem. Even so, he must approach that procedure creatively to successfully find the solution.

Essentially, troubleshooting is an art. Overly esoteric, you say? Maybe. Let's modify that definition, then, to a craft. It requires some imagination, ability, technical knowledge, and that old undefinable quality: common sense. Troubleshooting requires deductive reasoning and most importantly, goal orientation. The goal is to get that circuit operational as quickly as possible, at the least possible expense. And, in spite of our professional pride, sometimes it is not cost effective to repair a board we (or our customer) can replace more cheaply than repair.

So troubleshooting is a practical craft, but one which requires that we shift our mind from a procedural mode to a deductive mode. There is one set of steps to narrowing down a problem. One must pursue those gremlins wherever they take us.

All You Need Is...

In an ideal situation you would be provided with schematics, component layouts, parts lists, and hopefully some training ahead of time relating to the quirks of a particular circuit. Some technical manuals provide voltage levels and oscilloscope patterns as well as operational descriptions. Others have troubleshooting flow charts, most of which are practically useless, as guides. (I have always found it is simpler to learn the circuit than to learn the troubleshooting chart.) Best of all, on some of the new computer based systems, self diagnostic programs can, with limited success, pinpoint faulty components and display the information on screen or via printer.

Now I did mention the above situation is the ideal. On the other end of the

spectrum is the following scenario: Someone drops off a printed circuit board totally encased in clear epoxy with three wires sticking out. You can see that there are 13 resistors, 4 capacitors, 1 integrated circuit, 2 transistors and one triac. All components have had their numbers removed.

Your first reaction is: "You've got to be kidding", and send it back. Then you see the tag on it.

"Please repair this fringe-area-localizer. It is NFG. (They told us in school that means Not Functioning Good.) The manufacturer says they can no longer supply the board and the new version is only $2499.99. The machine it controls is losing $500/hr while down. We need it by 4 P.M. Thank you. Thank you. Bless you."

"P.S. Please find enclosed a blank cheque for your trouble."

Perhaps we'll reconsider. After all, how hard can it be to repair?

A bit overstated perhaps, but it makes the point. There are times when repairs must be made on a circuit for which there is no information whatsoever. How do you approach that situation?

The Non-Procedure

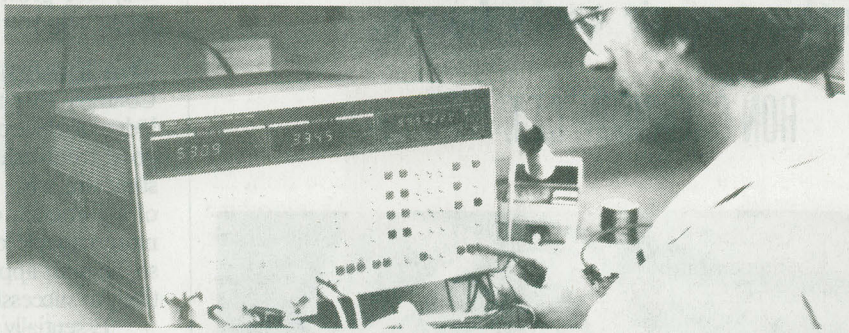
Having previously stated that there is no one procedure for troubleshooting, I now proceed to list one. Actually, this is just a list of questions and suggestions which may help you make some choices. The technical knowledge and analysis of information gained is all in your hands. In the immortal words of IBM: "THINK!"

Step 1. What is this thing anyway?

It stands to reason that if you don't know what the basic function of the circuit is it will be more difficult to test and/or repair. This may be the first time you have tackled this particular unit. Try to obtain as much information as possible from its owner/operator. Also find out what the fault is and how or when it exhibits itself. A circuit may perform many functions, of which only one may be faulty. Also, don't assume it is faulty just because you have been asked to fix it. Often customers bring me equipment for repair which is not faulty.

Step 2. What information do I have on the circuit?

Keep a file of any information you may have on a particular board. Jot down any notes you may think relevant. Don't assume you will remember. This can make the difference, at least on the second time around, whether you can repair it within a reasonable length of time or not. Often schematics, etc. can be obtained from the manufacturer's representative, but if that is not possible perhaps the owner or distributor will have some information. Often a good relationship with the competition can pay off in this respect. If a complete schematic is not available you may be able to obtain a block diagram at least showing signal flow, power supplies and connection diagrams.



Step 3. Visual inspection

How many times have you worked on a circuit for a length of time before finding a broken wire, cold solder joint or burnt track or component? A quick visual check can often turn up the only problem, allowing you to turn around the board at a profit. Also information pertinent to the operation of the circuit is sometimes silkscreened onto the board.

Step 4. How does it work?

At this point you need to know as much as possible about how the circuit works. Using the information discussed above, set it up for testing. If information is not available, you may have to try to draw the schematic by examining the circuit board. This is no simple task, but in some cases, can be done.

Step 5. Testing

This is the step where the deductive reasoning comes in. Conceptually, from one circuit to the next, testing will vary. Moreover, even when troubleshooting the same kind of circuit, procedures change because the problems will be different. You have to evaluate all the information gathered and use it to decide where to start and what direction to go. You want to narrow the problem down with each test by process of elimination. If a signal is injected into the front end but the expected response is not present at the output, you must follow the signal through, eliminating stages by testing to confirm that they do work.

Your first priority in testing is to determine if the circuit is actually faulty and if so, what the symptoms are. Those of you who have done any amount of troubleshooting can attest to the corollary of Murphy's Law that states: "Any circuit which is intermittently faulty will operate normally while in the presence of a technician." This can make your job difficult.

Usually intermittents are a result of a physical problem causing a bad connection somewhere, or a thermal breakdown creating the fault when the component warms up. The first case can sometimes be tested by tapping the circuit board or assembly lightly with a non-conducting object. The thermal intermittent can be detected by warming up the board with a heat gun and then cooling individual components with freeze spray.

Assuming that you have a circuit with a constant fault, what should you do? First, based on the information you have, and tests done so far, determine whether all functions of the circuit are faulty. If so, you might suspect a common part of the unit such as the power supply or a loss of signal at the input. An example of this might be a stereo amp where both channels are not functioning. Often they will operate off a common supply. If one channel operates but not the other common sense would direct you to look for a loss of signal somewhere along the signal path.

Following the Path

An amplifier is a good example to use because of some of the problems which can arise. Let us say that we are tackling a problem in the left channel. We know the power supply is good; we have injected a sine wave into the input; and we have a good signal right up to the output stage. So far we have used good linear signal tracing to assure ourselves the low level stages are operating. Now we find ourselves working on an output stage that uses negative feedback. We have a distorted signal at the output, but this distorted signal is being fed back to the beginning of the output stage. Where does the distortion begin? We must come up with a different kind of test which will allow us to narrow the problem down to a component. We might do some DC bias voltage checks on the stage to make sure all the transistors are being properly turned on. Also, this being a stereo amp, we could compare voltages between channels. On the other hand, by turning off

power and doing a quick resistance check of the transistors we might find the problem even faster.

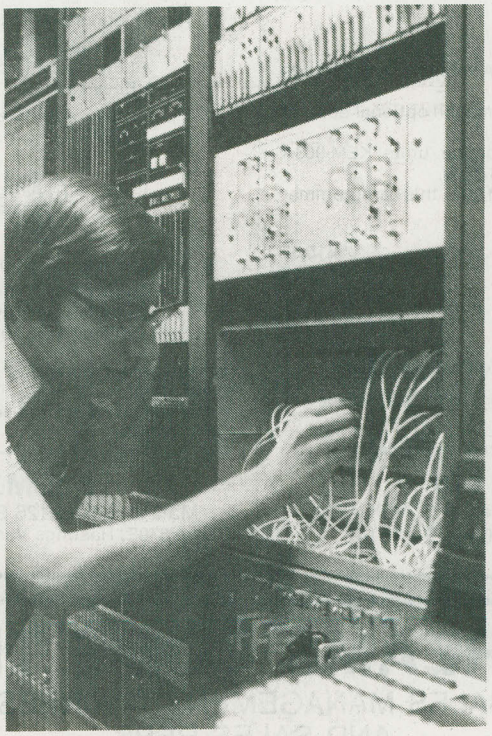
Now let's say that in checking the transistors we find an open emitter resistor and a shorted output transistor. We happily replace both, plug the unit in, and it blows up again. How are we going to find the main problem with the circuit if it blows up every time we turn power on? Devise another way of testing it. We could again try to find a bad component, with power off, using an ohmmeter, but often this does not turn up the answer. Another test can be done by applying mains power through a variac and bringing up the voltage slowly while watching an indication of the AC current being drawn. Tests can be made at lower power supply voltages which may point you in the right direction. Also, once a component is changed, the power can be brought up slowly to see if all the problems have been found.

A moment ago we mentioned power supply problems. What about the situation where the circuit is loading down the power supply? Sometimes the offending component can be identified by the heat it is dissipating. There are probes available which can be used to detect a trace which is conducting more current than normal, but when one of these is not available, what can we do? Although it is sometimes frowned on, judicious track cutting can quickly localize the problem. Using an X-acto knife, start at the first branch of the power supply, and carefully cut the track on the printed circuit board. Next recheck the power supply. If it is no longer being loaded down you are going in the right direction. Proceed along this line until you localize the offending component. A word of caution: don't forget to reconnect the cut track.

Test Equipment

Still on the subject of testing we get the "tracker" type test device. There are various commercially made units on the market but a simple but effective equivalent can be made cheaply and connected to the X and Y inputs of your oscilloscope. For the uninitiated, a tracker displays a signature pattern on the scope when the probes are connected across a component's leads or two points on an unpowered circuit board. Essentially what happens is that a current limited AC voltage is impressed across whatever is connected to the leads. The voltage that is dropped across this load is shown on one axis of the scope while a fixed AC voltage is applied to the other axis. Certain standard patterns are generated on screen due to the resistance and impedance of the device being tested. If you, through experience, can tell what is a good pattern and what is bad, you can find faults in the circuit. Also, if you have a good board handy, you can compare the two. More sophisticated equipment is available which uses a computer to compare the pattern measured with predetermined patterns.

The tracker can be a very handy device, especially in situations where no information is available or standard testing is not viable for some other reason. However, some technicians maintain it is the total answer to troubleshooting. I disagree. Being a very subjective type of test, sometimes two circuits can have slight differences which show up on the tracker but are not truly problems with the circuit.



Also if you do not have a good board to compare to, it is difficult to know if some of the more complex patterns indicate a problem or not. The tracker is somewhat of a mindless device and should only be used as a method of last resort.

In terms of the technical aspects of testing, we could go on and on. However, our purpose here is to discuss the concepts of how to approach the problem. For the technical aspects of testing volumes have been written and are readily available. Suffice it to say that good troubleshooting requires that you know when and how to use a particular approach.

Step 6. Parts and repairs.

Sure enough, now that you know which part is faulty, somebody expects you to replace it. Simple. But not always. Remember our "fringe-area-localizer" example? Sometimes manufacturers will erase the component markings or use house-numbered parts so people like us can't repair their equipment. When this happens about the only recourse you have is to try to "reverse design". If you have the schematic or can draw one you will have to identify the component by its pinout, function and an analysis of its electronic parameters. For example, you have a circuit with an eight pin DIP integrated circuit. You find out from your schematic that it is operating as a dual op amp from a single supply. On one op amp pins 2 and 3 are the inputs and 1 is the output. With have experience, you know that the chip is likely to be a LM358. If you don't, you can spend some time doing research and make an educated guess.

The same problem can occur if you have components that have been charred by heat. In addition to replacing the component, sometimes the printed circuit board is damaged and must be repaired. In some circuits where higher voltages are present a charred epoxy board can actually act as conductor, allowing arcing to happen. Cutting out that portion of the board will cure the problem.

When track is blown off the board it can be replaced with track from discarded boards or with commercially available kits sold for that purpose.

Step 7. Am I finished?

No. Head back to Step 5 to retest and confirm that everything is working.

Step 8. Is this thing ready for the customer?

Once you are sure that the board is working give it one more going over to make sure all solder joins were done properly, all cut tracks are rejoined, everything reconnected and adjusted. If the board needs to be cleaned of flux or sprayed with conformal coating it can now be done.

By combining a determination to successfully repair a piece of equipment with a creative use of technical knowledge, a lot of those dead-end repairs can be avoided. As a last resort, if you are stumped, set it aside for a while and take a fresh look at it later. Always be thinking of a new, incisive approach which will tell you what you need to know about the circuit. You are a detective, and your assignment is to dig out those gremlins wherever they may be. So get after 'em. Good hunting. ■

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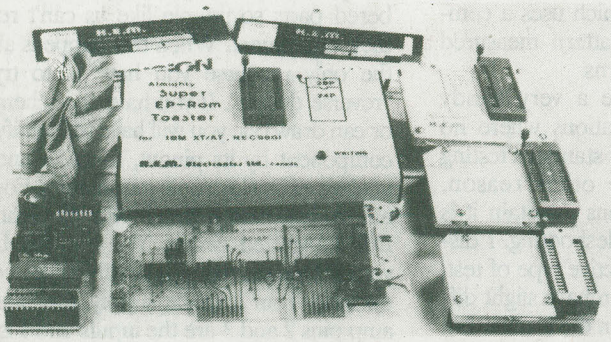

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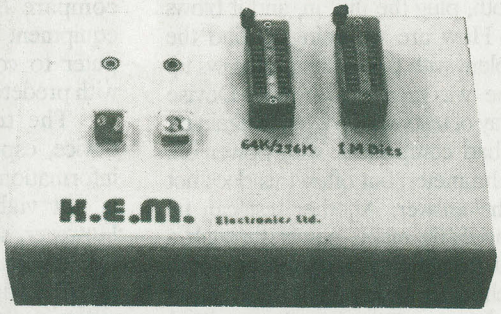

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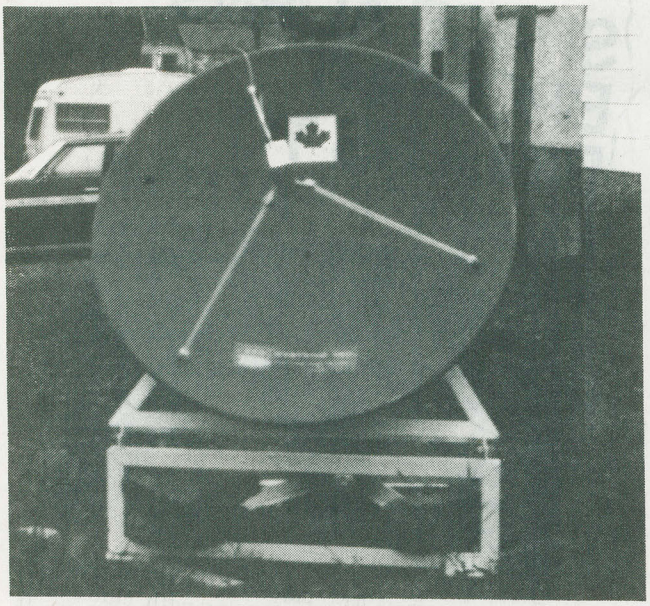

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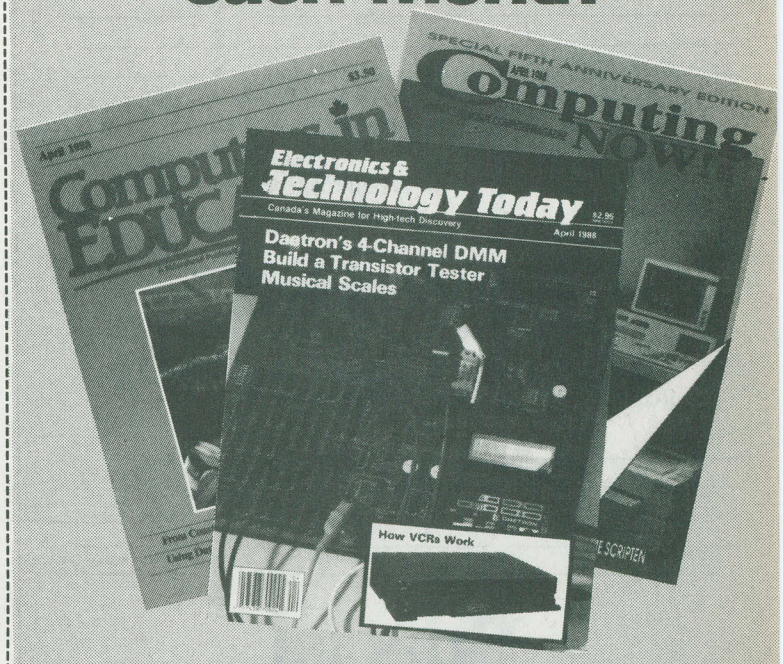

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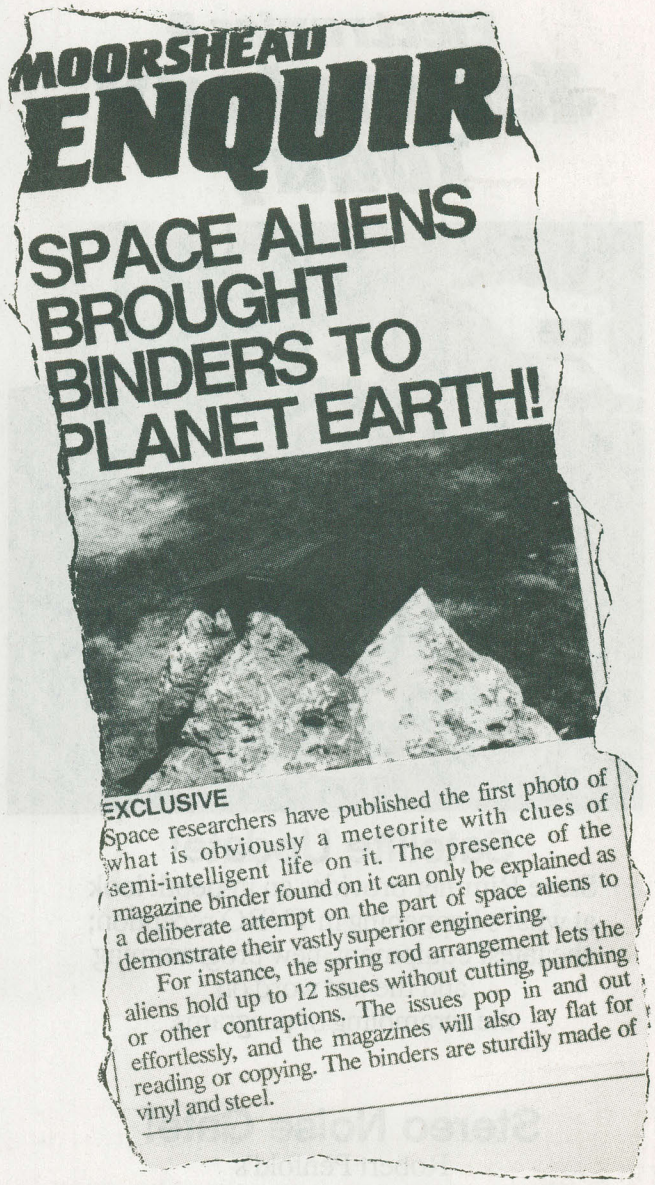

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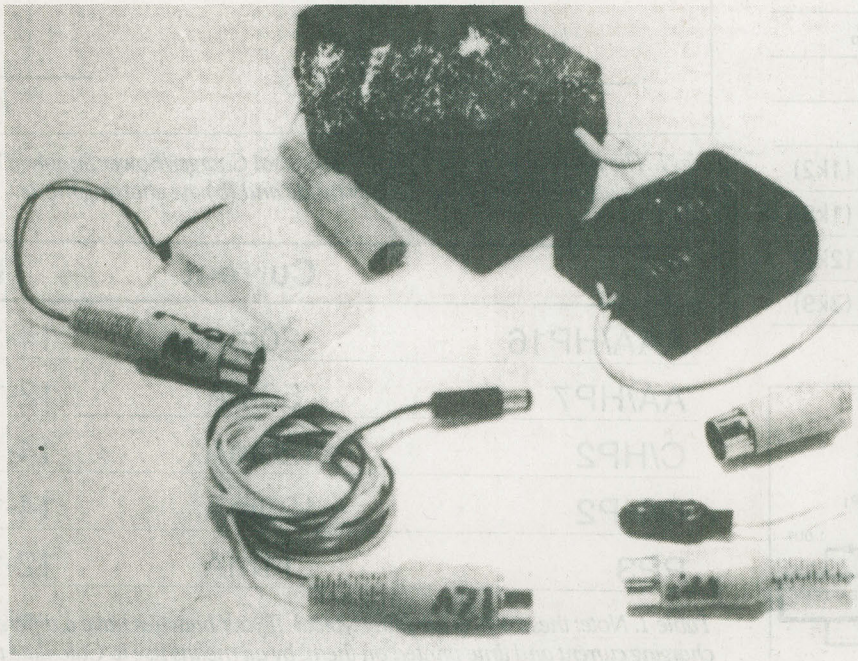
Universal Charger/PSU

A power supply/charger that automatically sets its own output voltage.

COSTAS CALAMVOKIS



Nickel-cadmium batteries (NiCads) are so cheap in the long run that it's a wonder that ordinary non-rechargeable batteries are still used. The Universal Charger/Power Supply Unit shown here will give you the opportunity to discover these savings. It is able to charge almost any size of cell and will also double as an AC mains adapter so you don't have to drain the batteries while using the equipment at home.

The problem with NiCads is that a constant current source is needed to charge them, and although there are many cheap chargers on the market, this unit offers certain advantages over similarly priced commercial ones. The first is, of course, its ability to act as a mains adapter, but there are more subtle advantages.

Most cheap commercial chargers do not actively regulate the current delivered to the batteries, so this current depends to some extent on the resistance of the cell or cells under charge.

Charging Rate

Another problem is that although different batteries have different recommended charging currents, these chargers usually only have one charging current (although different sized batteries can be inserted) and so often small cells are charged too fast, shortening their life. To make matters worse large cells are charged too slowly, unnecessarily increasing the charging time.

This unit avoids these pitfalls by having an "intelligent" plug socket into which a battery holder is plugged. This socket detects the size of the batteries to be charged from a resistor mounted in the plug and the current is set accordingly.

The current is actively regulated so it does not change during use. The constant voltage is also regulated when used (unlike many cheap mains adapters whose voltage depends on the loading which show marked voltage rises at low current).

The resistor which controls the constant voltage is also mounted in the plug, so if a different lead is made for each item to be powered the correct voltage will always be delivered.

The unit will charge one 9V battery or up to six AAA, AA, C, or D cells at once (depending on the size of the battery holder used). Only one type of battery can be charged at one time; see Table 1. Alternatively, the unit could act as a mains adapter delivering from 1.5V to 12V at up to 400mA.

Circuit Operation

The full circuit diagram for the Universal Charger/Power Supply is shown in Fig.1. The mains is brought down to about 12V AC by the transformer T1. This is then rectified by the bridge arrangement of

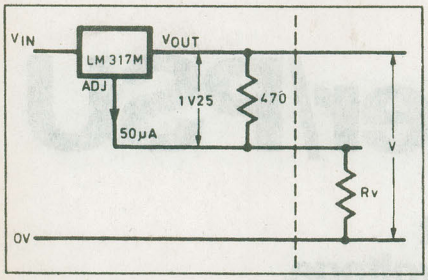


Fig. 2. Simplified regulated power supply. The value of RV can be found by referring to Table 2, below.

Voltage	R_V ⅛W, 5%
1.5V	100ohms
3V	680 ohms
4.5V	1200 ohms (1k2)
6V	1800 ohms (1k8)
9V	2700 ohms (2k7)
12V	3900 ohms (3k9)

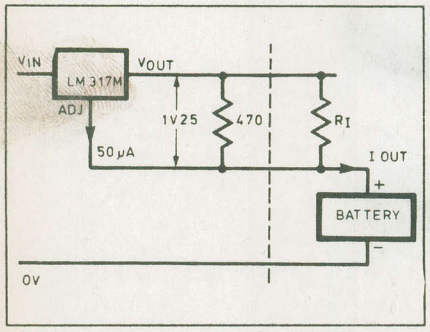


Fig. 3. Simplified arrangement for charger operation. The value of the charging resistor R1 can be found from Table 3, below.

Battery type	R_1
AAA	82 ohms ⅛W 5%
AA	27 ohms ⅛W 5%
C	12 ohms ¼W 5%
D	12 ohms ¼W 5%
PP3	180 ohms ⅛W 5%

Note: Table 3 values are based on the currents given in Table 1. They are independent of the number of batteries to be charged.

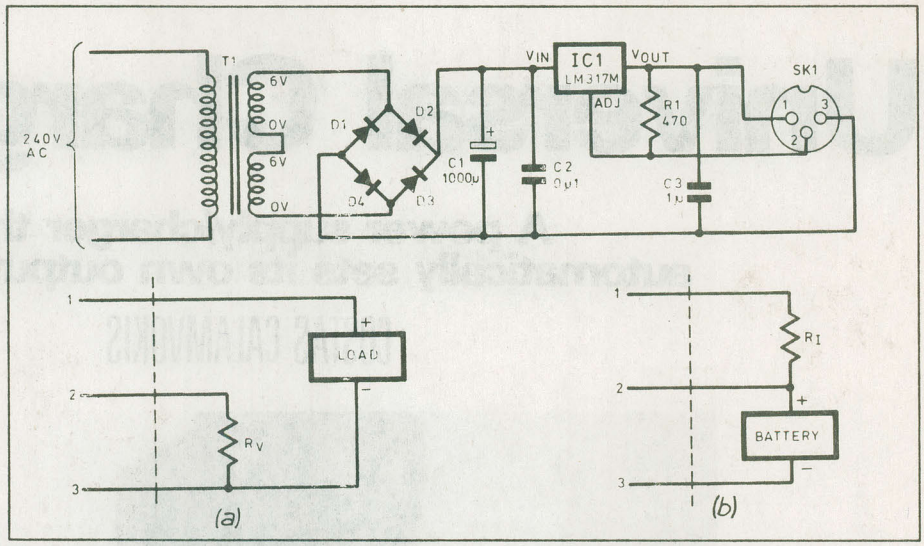


Fig. 1. The full circuit diagram for the Universal Charger/Power Supply. The two small diagrams are for (a) the power supply mode and (b) the charging mode.

	Current	Time
AAA/HP16	20mA	14-16 Hours
AA/HP7	50mA	12-14 Hours
C/HP2	120mA	14-16 Hours
D/HP2	120mA	14-16 Hours
PP3	11mA	12-15 Hours

Table 1. Note: these values are fairly typical. If your batteries have a different recommended charging current and time printed on them, by all means use it. Calculate the value of R1 from the formula given in the text. If the charging current is higher than 200mA, use a 1/2W resistor. R1 shold not be decreased below three ohms.

diodes D1-D4 and smoothed by capacitor C1. Capacitors C2 and C3 remove spikes.

The only active component is an adjustable voltage regulator, IC1, which works by adjusting the voltage at the V out pin so that it is 1.25V higher than the voltage on the adjust pin (ADJ).

In the power supply mode of operation the circuit is as shown in Fig.2 (simplified). Between the V out and ADJ pins is a 470 ohm resistor (R1). As the voltage across it is always 1.25V the current is always:

I = V/R = 1.25/470 = 0.0027A = 2.7mA

As the current flowing out of the ADJ pin is only 50mA it can be ignored, so the current through resistor Rv is always 2.7mA. The output voltage is the sum of the voltages across resistors R1 and Rv and can be calculated from

Vout = 1.25 + (IxRv)

= 1.25 + (0.0027xRv)

so Rv = (Vout-1.25)/0.0027

From this formula values for Rv can be calculated for whatever supply voltage is required, from 1.5V to 12V. See Table 2.

Constant Current

When the unit is acting as a Charger the circuit is as shown in Fig. 3. Resistor R1 is placed in parallel with resistor R1 and the current which flows through them also flows through the batteries being charged. As the voltage across resistor R1 and R1 is kept constant by regulator IC1, so is the current that flows through them. In this way a constant current is maintained through the batteries.

This is calculated from:

Iout = R1's current + R1's current

= (1.25/470) + 1.25/R1)

= 0.0027 + 1.25/R1

so R1 = 1.25/(Iout-0.0027)

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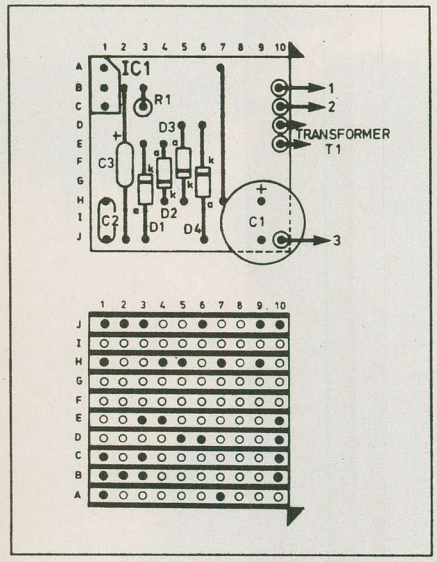


Fig. 4. Component layout and details of wiring to the transformer secondary winding and to the DIN socket.

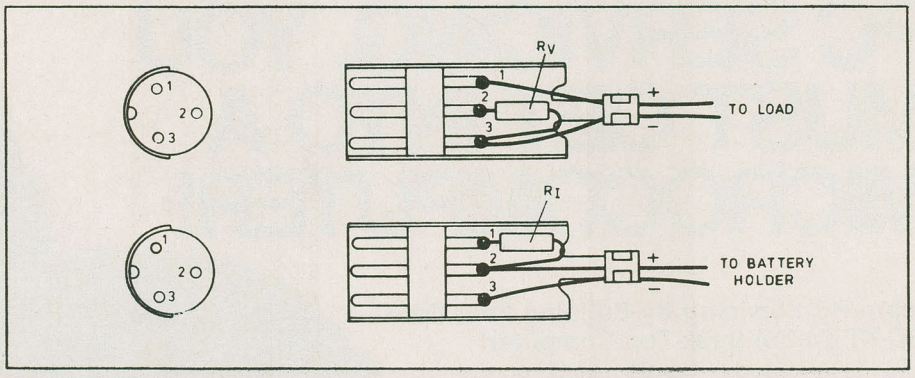


Fig. 5. Wiring to the DIN plugs for power supply and charger mode. It is suggested that the resistor leads be covered with insulating sleeving to avoid shorting to the other pins.

Constrctuion

The circuit is built up on a small piece of 0.1in. matrix stripboard, size 10 strips by 10 holes. There are no track breaks on the board and the component layout is shown in Fig.4.

Commence construction by mounting the diodes and link wire on the board followed by the capacitors. The regulator IC1 should be soldered on last and a small heatsink bolted on to it. When mounting the diodes and electrolytic capacitor C1 be sure to observe the correct polarity of these devices.

The completed circuit board is housed in a power supply unit box with an integral 3 pin plug. The miniature mains transformer was fitted first by bending its mounting tags round the box's internal moulding and the circuit board was connected to it using stiff wires. If a 0-6V,0-6V secondary winding is used, the wires to the circuit should be connected to the OV of one winding and the 6V of the other, with the remaining two tags connected together.

In the prototype unit the DIN connecting socket was a non- chassis type and a short lead was attached to the socket, fed through a small hole in the case side and soldered to pins on the circuit board. If a chassis type socket is used a suitable hole should be drilled in the case and short wires soldered from the circuit board pins to the socket tags. As the components are such a tight fit inside the case it might be best if constructors kept to the external-lead type DIN socket method.

Connecting Leads

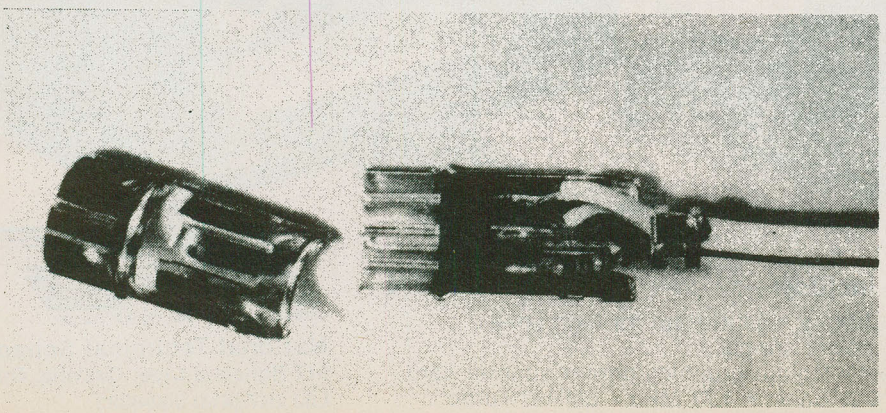
The construction of the battery charging and power supply leads are shown in Fig. 5. Some care is needed when mounting the resistor in the plugs to ensure that the leads do not touch any terminals. For this reason plastic-barrelled plugs should be used, and wrapping the resistor in insulating tape is not a bad idea either.

For charging large batteries higher power resistors are used (half or quarter watt types - see Table 3) and these may not fit in the plug barrel. If this happens the resistor should be mounted on the battery holder, and a three-wire plug lead will then be needed.

NiCADS

The life of your NiCADs can be drastically shortened if they are mistreated, so some care is needed. They should not be used in very low current applications such as clocks and LCD calculators where a dry cell would only be replaced once a year.

NiCADs should never be short circuited as they have very low internal resistance and can, if shorted, deliver very high currents which may destroy the cell itself. The recommended charging times should be kept to, but no real harm results in charging for too long. Ordinary zinc-carbon or alkaline cells are not meant to be recharged, and damage may result; recharging of these should not be attempted. ■



PARTS LIST

Resistors

R1 470
Ri See Table 3
Rv See Table 2

Capacitors

C1 1000u, 35V
C2 0.1u
C3 1u tantalum bead

Semiconductors

D1-4 1N4001 or equiv
IC1 LM317 adjustable regulator

Miscellaneous

12V 500mA transformer such as Hammond 166G12 or similar. If a plugpack case is not available, the circuit can be put in any utility case and a line cord attached.

3-pin DIN socket and suitable power plugs, stripboard (Vectorboard), battery holders.

Introducing Microprocessors Part 7

Interfacing LEDs and relays to the parallel port of a microprocessor system.

MIKE TOOLEY

In part six we explained some of the virtues of a typical programmable I/O device. Unfortunately, such devices also have a number of shortcomings, not the least of which is associated with the inability to provide sufficient voltage or current drive to an external device or load.

The maximum current which can be sourced from a typical programmable I/O device is limited to about 1mA at a voltage of 1.5V, and clearly this will be inadequate for directly driving all but the most modest of loads; in order to operate external devices such as LEDs or relays an appreciable current or voltage may be required.

LEDs

In order to provide a reasonably bright output, a single LED will generally require a supply current of around 8 to 12mA. Such a current is usually provided by simply wiring a resistor in series with the LED and connecting the resulting series circuit to a supply having a nominal voltage of 5 to 12V. As a general rule of thumb, a typical voltage drop of about 2V appears across an LED in which 10mA is flowing.

Greater light output can be produced from the LED by increasing the forward current and this can be achieved by either reducing the value of the resistor or raising the voltage of the supply (note that it is essential to keep within the manufacturer's recommended maximum ratings for the device). A reduction of light output, on the other hand, can be achieved by increasing the resistance value or reducing the supply voltage.

As an example, let's consider the case of a standard red LED which is to operate from a conventional TTL supply voltage of +5V. The LED would be connected as shown in Fig. 7.1 and the value of the series resistor calculated from the formula:

$R = (5 - Vf)/If$

where Vf is the forward voltage of the diode and If is the forward current.

Assuming that the LED exhibits a normal forward voltage of 2V at a forward current of 10mA, the required value of resistance is thus:

$R = (5 - 2)/0.010 = 300$ ohms

The nearest preferred values are 270 or 330 ohms and a 0.25W resistor of either value will be adequate as the series resistance.

On a rather more practical note, it is essential to observe the polarity of an LED when connecting it into a circuit. Such devices cannot withstand reverse voltages of more than a few volts, and failure to observe this precaution will often result in permanent damage to the LED. The conventional polarity markings for a standard LED are shown in Fig. 7.2.

Relays

Electromechanical relays are available in a wide variety of forms, including miniature dry reed, dual-inline, PCB mounting and plug-in types. Low-voltage DC relays generally have coil resistances between 100 ohms and 3 kilohms and operate from voltages in the range of 3.75V to 24V.

A typical relay for use with a microprocessor system will operate with a current of about 20mA and be capable of switching currents of up to 3A. The characteristics of some representative

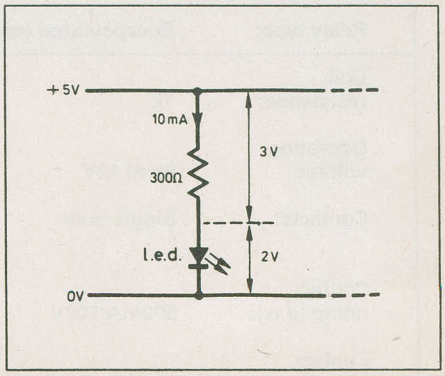


Fig. 7.1. An LED operating from a +5V supply rail.

relay types are shown in Table 7.1.

An important property of a relay is that it can offer very high degree of electrical isolation between the microprocessor system and the controlled circuit. This is particularly important in applications where the controlled circuit is connected directly to the AC supply.

Problem 7.1

An LED is to be operated at the manufacturer's ratings, which are:

Vf = 2.4V and If = 15mA

Assuming that the LED is to be used with a 5V supply, determine the nearest value of the preferred series resistance.

Problem 7.2

A relay has a coil resistance of 700 ohms and requires a nominal operating voltage of 9V. Determine the current required to operate the relay.

Transistor Drivers

The simplest method of interfacing an LED or relay to a parallel I/) port is with the aid of an NPN switching transistor, as shown in Fig. 7.3 and 7.4. Transistors provide current amplification (typically on the order of 50 or more) and are also able to tolerate a much higher load voltage than would be possible with a conventional TTL device.

In the LED driver arrangement of Fig. 7.3, the transistor will be driven into conduction whenever a high level (logic 1) is produced by the port output line. The transistor is operated as a saturated switch, and sufficient base current must be applied for the collector-emitter voltage to fall to a value close to zero. In this condition, the collector current is determined by the supply voltage and the value of the load, rather than by the current gain of the transistor.

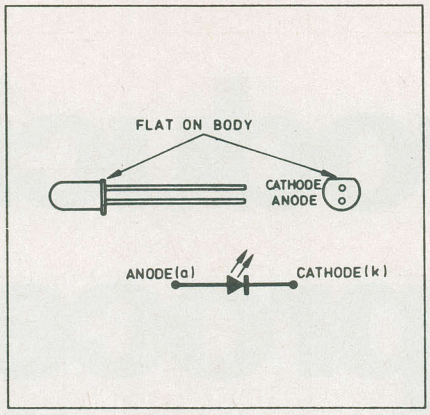


Fig. 7.2. Typical polarity markings for a round LED.

A base current of approximately 1mA will produce saturated switched with the vast majority of modern silicon transistors, and thus a typical value for the base resistor is 4k7. Fig. 7.5(a) and 7.5(b) show the equivalent circuit of a transistor LED driver in the nonconducting (logic 0) and the conducting (logic 1) states respectively.

The operation of the transistor relay driver in Fig. 7.4. is similar to that of the LED driver in Fig. 7.3; however, an additional diode is connected across the relay coil in order to protect the transistor from the effects of back EMF (the reverse voltage generated by the collapse of the current in the coil inductance whenever the transistor switches off).

Open-collector Logic

Another method of increasing the current drive of an output port is with the aid of a TTL buffer. Six identical buffers are usually contained in a single dual-inlinepackage and each device has a single input and output.

Two types of buffer are available: inverting and non-inverting. An inverting

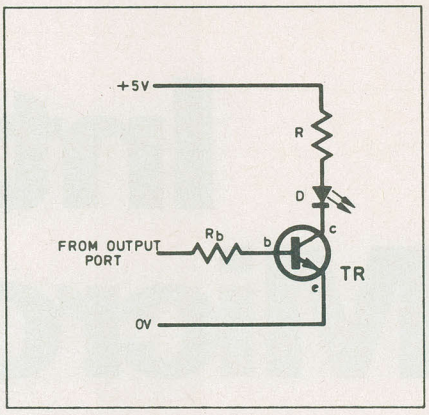


Fig. 7.3. A transistor LED driver.

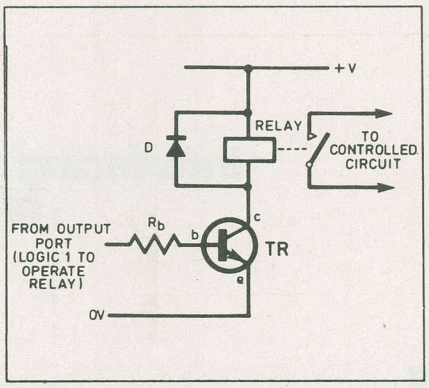


Fig. 7.4. A transistor relay driver.

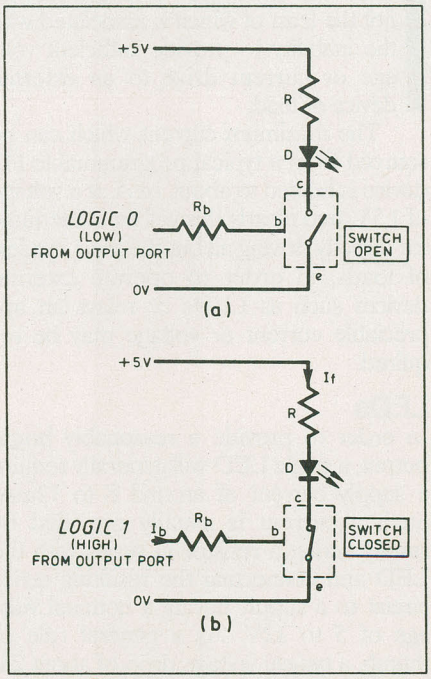


Fig. 5. The equivalent circuit of a transistor LED driver with (a) logic 0 from the output port and (b) logic 1 from the output port.

Table 7.1 Characteristics of some representative relays

Relay type:	Encapsulated reed	Miniature p.c.b.	Plug-in
Coil resistance:	1k	320 ohm	185 ohm
Operating voltage:	9V to 12V	8.4V to 14.4V	8V to 17V
Contacts:	Single pole	Single pole changeover	4-pole changeover
Contact rating (d.c.):	500mA/100V	1A/28V	1A/110V
Contact rating (a.c.):	500mA/120V	500mA/120V	2.5A/120V

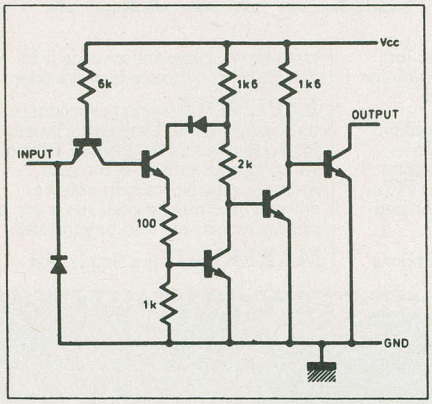


Fig. 7.6. The circuit of a single open-collector TTL inverting buffer (7406 or 7416).

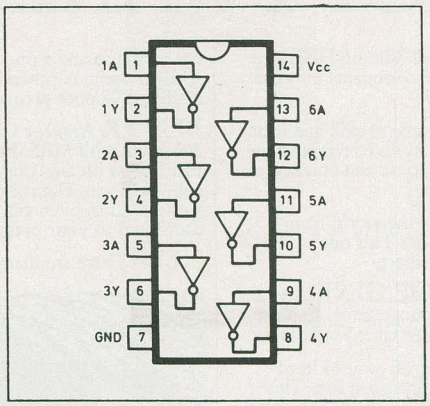


Fig. 7.8. The pin connections for the 7406 and 7416 open- collector inverting buffers.

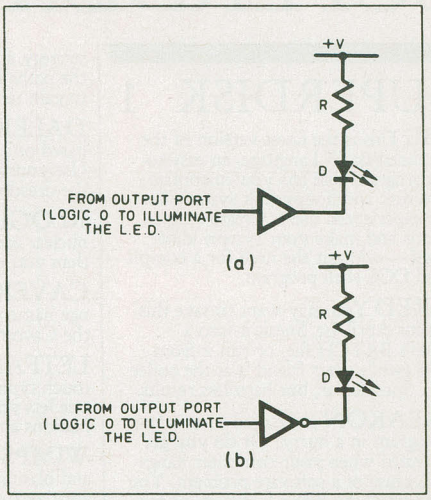


Fig. 7.10. An LED driver using an open-collector TTL gate; (a) a non-inverting buffer (7407 or 7417), and (b) an inverting buffer (7406 or 7416).

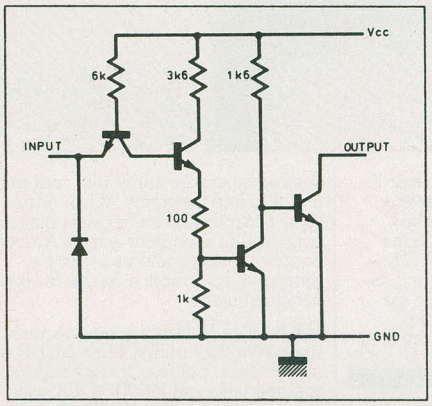


Fig. 7.7. The circuit of a single open-collector TTL non- inverting buffer (7407 or 7414).

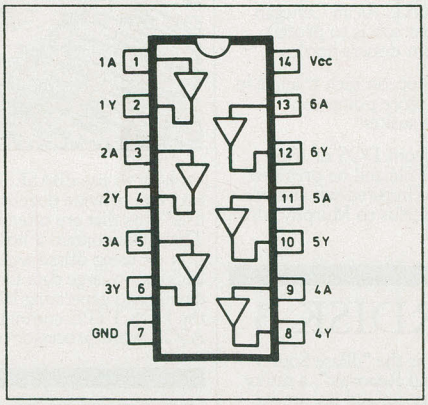


Fig. 7.9. The pin connections for a 7407 and 7417 hex open- collector non-inverting buffer.

buffer produces a low state output when its input is high and high state output when its input is low. A non-inverting buffer, on the other hand, produces a high state output when the input is high and a low state output when the input is low.

Buffers are often fitted with open-collector output stages so that they can be used with external loads in a similar configuration to that adopted with the transistor drivers described earlier. Furthermore, the transistor output stage is usually designed so that the device can tolerate a high supply voltage (note that the early stages of the TTL buffer still require a +5V supply). Details of some typical TTL buffers, both inverting and non-inverting, are given in Table 7.2, while Fig. 7.6 to 7.9 show the circuits and pin connections for two of the most popular types of inverting and non-inverting buffers.

Table 7.2 Characteristics of some typical TTL buffers

Type	Logic function	Load current (max.)*	Load voltage (max.)
7406	Hex inverting buffer (open-collector)	40mA	30V
7407	Hex non-inverting buffer (open-collector)	40mA	30V
7416	Hex inverting buffer (open-collector)	40mA	15V
7417	Hex non-inverting buffer (open-collector)	40mA	15V

*measured with the output in the low state.

Typical LED driver arrangements based on inverting and non- inverting open-collector buffers are shown in Fig. 7.10. Note that the two circuits require logical signals of opposite polarity, and allowance must be made for this in the software routines used to send data to the port.

Representative Output

A representative output driver is shown in Fig. 7.11. Port lines PA0 to PA7 of the programmable parallel I/O device are configured for output. Lines PA0 to PA5 are connected to the inputs of a hex inverting buffer which is used to drive six LED indicators. The remaining port lines, PA6 and PA7, are connected to two NPN silicon transistors which are used as relay drivers.

In order to operate the LEDs and relays, a data byte is written to Port A. As an example, a binary value of 11000111 (hex C7) written to Port A will illuminate the three LEDs connected to PA0, PA1 and PA2, as well as operating the relays connected to PA6 and PA7. To turn the LEDs and relays off, a binary value of 0000000 (hex 00) should be sent to Port A.

Problem 7.3.

Refer to the representative microprocessor output shown in Fig. 7.11.

(a) What data value should be written

Continued on pge 50

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CUTE TIME Friendlier than a clock program, but not as accurate, running QT gives on an English approximation of the time. "It's about half past two", for example.

DRAIN Another April Fool's program. Run DRAIN to remove the water from your disk drive. Keep 'em rolling in the aisles.

XEQ This utility is designed to let you manage those small but useful programs that tend to clutter up disks. Files can be added, removed and run from XEQ.

ORDER Use ORDER to change the order in which files appear in the directory on your disks. This utility will create order out of chaos in large directories. Great for hard disks.

TSR For SideKick, ProKey and SuperKey users — or anyone who uses co-resident software. This utility lets you remove co-resident programs (such as those mentioned above) from memory — without rebooting your computer!

SUPERDISK 2

BLOCKADE Play with up to two human and five computer players. This territorial game will generate hours of excitement. This version lets you select a number of game parameters such as strategy and speed. Win by blocking the paths of your opponents in order to gain territory.

DALEKS A game of skill and logic based on the Dr. Who television series. Use your talents to rid the universe of the dreaded Daleks.

RLOGIC Save the world from nuclear annihilation. This one is trickier than you might expect.

CAVERNS OF GINK A strange name for a strange game. Explore the Caverns and see what you'll find.

LETFALL A great way to learn touch typing and have fun too. This one lets you work on tricky key combinations and reports on your progress.

WIMPS Maneuver your spaceship and blast away at marauding wimps. A great zero gravity simulation.

FLIGHTMARE As an Omegan jet fighter ace, your job is to protect your factories from dessert hordes.

PYRAMID Hop on each triangle in the pyramid and score points, but watch out for the snakes!

HI Just run Hi from DOS or from within a BATCH file and be prepared for a daily dose of inspired wit and wisdom. From Confucius to Murphy, this program has it all.

SUPERDISK 3

DSCAR This is the "dBase Source Code Analyzer and Reporter", a utility that lets you pretty up and document your dBase programs. This program is very flexible in analyzing your files. You can even edit the reserved word list so that it will work with future updates of dBase III as well as with dBase compilers such as Nantucket's Clipper.

SET COLOUR A simple, but well written routine that can be called from within any dBase program. This one lets you install screen colours.

DB-CHECK Check the logical flow of your dBase programs and have this handy utility indent your programs so that they are more easily read and debugged. This one is fast!

FLOW A quick program flow checker that matches up DO's and ENDDO's, IF's and ENDIF's and DO CASE's and ENDCASE's. It makes those hard to find errors easy to find.

DB3TOPAS Not an everyday utility, DB3TOPAS creates Turbo Pascal routines that can access dBase III files.

LBARGEN This is a simple dBase III Light Bar menu generator. Just enter the options for your application and LBARGEN will generate a .PRG file, saving you the time and energy required to do it yourself.

DL1B This is a shareware Clipper library which can be linked with any Clipper program. There are all sorts of great routines in this one — everything from screen handling functions to financial formulae and a phone dialer for modem users. A powerful addition for all dBase/Clipper programmers.

BEEPER Another Clipper utility. Assemble with MASM and link BEEPER with any Clipper program and you'll gain control over the PC's speaker. Alter pitch and duration and add sound to your programs.

HELP There are many good books on how to use dBASE III, but these 7 text files provide dozens of "power user" tips that are often overlooked. These files contain a host of information on using dBase with Lotus 123, backing up large data files, printing, indexing and generating labels. Just use the DOS TYPE command or any ASCII word processor to read the files.

SUPERDISK 4

TREND is an easy-to-use program that lets you make projections based on past historical data which the use enters. The program can display both line and bar-graphs.

EE2 is a handy "Environment Editor" that lets you make quick changes to DOS PATH and SET commands. The few simple commands needed to run this utility are explained in a small help screen. Requires DOS 3.1 or higher.

PCSTYLE A public domain program which tests your prose and provides a quick test for readability. While not a substitute for a competent English teacher, PCSTYLE can help you improve your writing style by providing statistics on word and sentence length, percentage of action verbs, etc.

PLANIT is an interesting appointment reminder program. By keeping all of your important dates in a text file (created with your word processor), PLANIT will check the file and tell you if you have any important engagements. A host of options enable you to set up messages which repeat weekly, monthly and yearly. It even warns you of important dates before they arrive!

CPU2 is a speed checker/benchmark program. It measures the speed of your IBM PC compatible system against a standard IBM XT configuration. The assembly language source code is included, so you can see how it's done.

EXPENDIT is good expenditure tracking program. Designed primarily for personal use, EXPENDIT lets you set up various categories for your monthly expenses to help you see where all the money goes. A variety of printed reports can also be generated.

MAKEREAD is a simple, and somewhat strange utility that converts text files into programs. When one of these programs is run, it prints the text contained in it on your screen. An odd program, but it could be useful for generating help short messages for inexperienced users.

REMINDER is a good on-screen clock/reminder utility. Press ALT-R to see the time. You can also enter daily appointments and REMINDER will chime when the time is at hand.

FORTUNE is a complete text simulation of one of TV's most popular game shows. All that's missing is Vanna and the commercials.

FIRE is a great little game which simulates a forest fire. You devise complex strategies using water bombers, etc. in order to quench the flames.

BLORTII is a fast-paced colour graphics game. You have to be quick with this one!

SUPERDISK 5

DR.COM Need to look at a file, or copy it - fast! Call the DR! DR.COM is a small assembly language program that lets you quickly call up the files in a directory. You can display files in order by name, date or size. Files can be viewed, copied, renamed, or deleted with a little help from the DR.

SIMCGA is the newest version of an indispensable utility for users with Hercules-type graphics cards. This one lets you flip back and forth between Hercules and Colour Graphics programs with two tiny utilities which can be run from DOS or Batch files. Yes, you can run CGA games with your Hercules card!

DATASCAN is a shareware

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SUPERDISK Software has been carefully collected from Public Access Bulletin Boards across Canada and the United States. All programs are belie
It is believed to be safe and compatible with all IBM PC/XT/AT and compatible computers. We cannot gua

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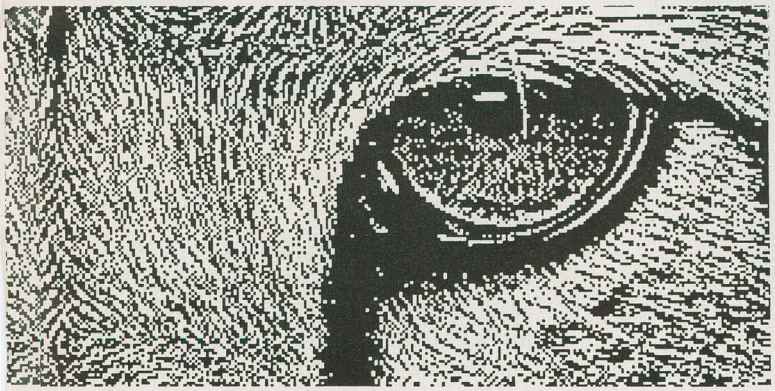
program which is designed to give scientists, statisticians and business users a quick overview of the relationships between the variables in their data. When you load a data file, DATASCAN plots an array of small scatter-graphs, showing the various relationships of up to nine variables. The user can "zoom in" on any graph for more detailed information. You can extract a variety of statistical information such as correla-



tion coefficients, and plot linear regression lines. DATASCAN is not intended to replace any of the more powerful statistical programs such as SAS, but it is powerful enough to enable you to detect statistical correlations within your data. This will pace the way for more indepth study. Requires a Colour Graphics Display. DATASCAN also works with EGA displays and Hercules compatible graphics cards using the SIMCGA utility included on this disk. Graphs can be printed on most dot-matrix printers if GRAPHICS.COM or replace graphics driver has been loaded. DATASCAN works with Lotus 1-2-3 .PRN files, or you can enter data direct.

ZENCALC is a small but powerful spreadsheet program which performs many of the mathematical operations available with commercial spreadsheets. Extensive on-line help is available by pressing the "?" key. ZENCALC is perfect for fast number-crunching.

PC-FLOW Flowcharting as a planning tool is often under used, simply because the use of templates can be very tedious. PC-FLOW is a flow chart designing program which makes flowcharting easy and fast. PC-FLOW lets you manipulate a variety of symbols and lines using either a mouse or the keyboard. Requires a color graphics card. A special file has been included that will let you PC-FLOW with a Mouse Systems Mouse.

SUPERDISK 6

YAHTZEE This is a great version of a classic game. Pit your wits against several other players, including the computer. Keeps track of high scores and has a good on-line help screen.

MAROONED — High adventure in space. Your ship has crashed on an alien planet and you must escape.

BLACKJACK — Lots of excitement and nothing to lose, this game plays a strong, but honest hand. Learn the strategy behind this diversion.

MAYAKDM2 is an enlightening text (with ASCII graphics) adventure game. You need a creative soul and a searching intelligence to escape the materialistic — and deadly — Mayan Kingdom. But greater and more meaningful pleasures can be yours if you can cross the ocean to freedom.

3DTICTAC Just like the name says, this is a 3- dimensional Tic-Tac-Toe game. And a mean game it is too! Just you and your computer in an all out battle of wits.

ICBM Save a city from nuclear annihilation. Blast those ICBM's before they blast you. Requires a colour graphics (CGA) card or equivalent.

CRSWRD is nice little program which lets you create your own crossword puzzles. It lets you enter words and clues, edit them, save them — and print them.

ROBOT is a clever game of strategy in which you maneuver a small creature around the computer screen. A number of robots will try to attack you. If the converge on you, the game ends. With careful maneuvering, you can cause the robots to destroy each other. There is also a teleport key — just to add a little more excitement.

SUPERDISK 7

ASTRO is an astronomy simulation program which graphically demonstrates planetary motion around the sun. It also performs a number of calculations such as lunar phases, sunrise and sunset times. Requires an EGA display.

TOFHANOI This is a nice implementation of a classic logic problem. The object of the game is tomove a tower of disks from one platform to another. But you can't place larger disks on top of smaller disks. Requires an EGA display and a logical mind.

TICK is a classic Space Invaders-type game - with a frightening twist. Maneuver a tank at the bottom of your screen and try to eliminate the giant bugs that are trying to get you. Just to keep things interesting, you can also take aim at the occasional rat. Requires a CGA display and fast reflexes.

SOPWITH2 lets you battle the Red Baron in a vintage World War I airplane. The program has realistic flight simulation - it will even stall and crash if you fly too high or too slowly. Requires a CGA display.

GOMOKU is an easy game to play, but a difficult game to win. Enter coordinates from the keyboard to place an X on the screen and try to place 5 Xs in a row. The computer will try to stop you - and you must use your wits to keep the computer from winning.

FOOTBALL is an nice NFL football simulation. It is very complete, allows you to choose any two teams you like and even includes details such as a coin toss to see which side kicks off. Choose each play from a huge "play book" and "make one for the Gipper".

HIQ is brilliant computerized version of a classic peg-jumping game. On a cross-shaped board you try to eliminate all of the "checker pieces" by jumping over them. The object is to clear all but one piece from the board. No special hardware requirements.

KILLER is a well-executed graphics-game that lets you shoot down the "killer bees". Requires a CGA display.

SUPERDISK 8

HAVE is a nice little system information utility that will provide you with information such as the number of installed serial ports, parallel ports, type of graphics adapter, number of floppy and hard drives and amount of memory. HAVE even draws a picture of your computer with extended ASCII characters, complete with printer, monitor and keyboard. Its a nice touch.

HANDLES is a small utility that shows you how many files DOS will allow open at the same time. The assembly source code is included to in case you want to see how it is run.

WCD is a nice little program that calculates flying times between world cities. Select any two international airports and you get a display showing their longitudes and latitudes and an estimated flying time. Distances in Miles and Kilometres are also shown. Handy for frequent flyers.

HLPURSLF is a resident help screen system. A series of HLP and MNU files are included to help you set up your own custom Help system. A great way to help new users learn about their computers.

UNIX has absolutely nothing to do with the operating system of the same name. This UNIX is a fast and furious pinball game. It does a great simulation of the real thing. Saves on quarters too.

VDE is a small full-screen text editor that could make a great programming editor. It's also good for "quick and dirty" text editing for BATCH files, etc. It only needs 11K of RAM, but it still boasts WordStar compatible commands and comes with an installation program to it can be customized for your own needs.

EP is a PATH editor which lets you quickly add or remove paths from your PATH statement. Small and fast, EP's program screen incorporates a complete list of editing commands to make altering you PATH statement quick and easy.

TAO is, well TAO just is, that's all. Based on the TAO of Programming, this program displays a random gem of wisdom from the Master Programmer every time you run it. More food for your AUTOEXEC file.

SUPERDISK 9

TAX87ONT is a comprehensive Lotus worksheet (version 1.X) for Ontario tax returns (unfortunately, we could not locate a similar worksheet for other provinces). TAX87ONT is an elegant worksheet which even includes all tax schedules. A split screen window lets you see whether you owe tax or vice versa. It's simple and easy to use.

BANKRUPT is a good worksheet for investors and potential investors. It lets you calculate the likelihood of a publicly traded corporation going bankrupt using "The Bankruptcy Predictor Formula", a formula was devised by Edward I. Altman, a financial economist at New York University's Graduate School of Business.

LOTUSX is proof that computers have been taken over by practical jokers. Run LOTUSX and an innocent looking worksheet is displayed. Press any key and the worksheet will actually "crumble" before your eyes! Slip it into a colleagues AUTOEXEC.BAT file.

HANGMAN is a competent version of the Hangman word game written as a 1-2-3 worksheet! It comes complete with simple ASCII graphics.

OIL is a simple worksheet which forecasts oil prices from a number of historical factors.

123LEARN is a menu-driven macro creation worksheet. Using Version 2.00 or higher, you can use 123LEARN to record keystrokes in order to create complex macros.

CHKBKC2 is a personal finance management worksheet which lets you balance monthly income and expenditures. You can even customize it to suit your specific needs.

TMPDOOM is a series of mystery adventure games created as a series of 1-2-3 worksheets. Because of the medium, TMPDOOM is not as extensive as most dedicated, commercial adventure games, but it is fun! Solve the mysteries by using your skill with Lotus commands. A great teaching tool.

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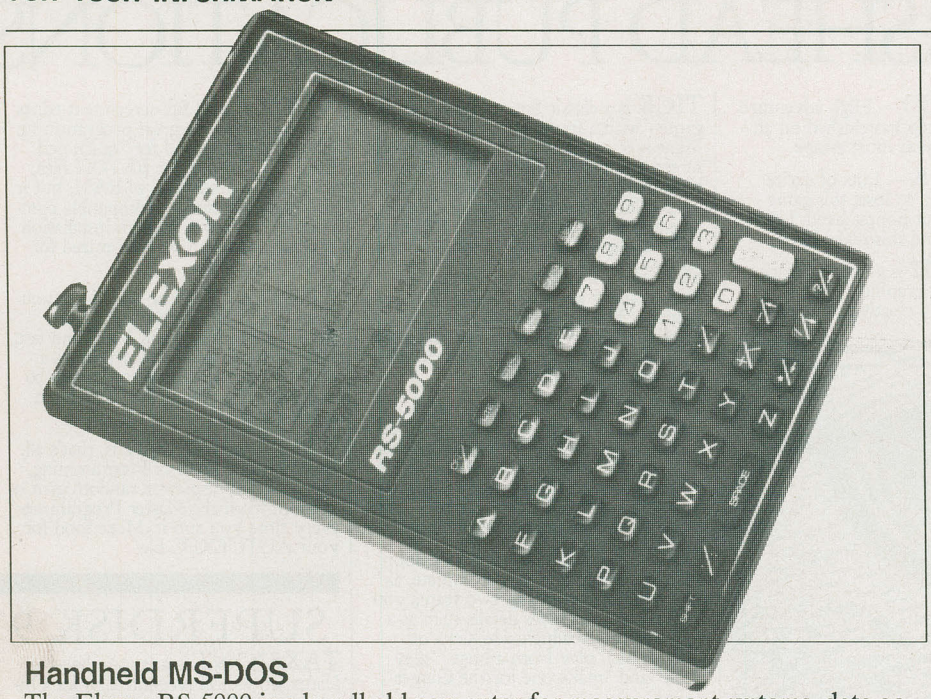
ed to be in the Public Domain. This software has been tried on a variety of computers, including XT's and AT's with and without hard disks.
ıntee that each program will work on every PC. SUPERDISKs can be exchanged for a full refund if you are not satisfied.



Handheld MS-DOS

The Elexor RS-5000 is a handheld computer for measurement systems, data acquisitions, control, etc., and includes its own A/D system and control software, as well as running most MS-DOS programs. Memory is 512K and the suggested list price is $4,790 US. Elexor Associates.

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ESD Simulator

The ETS Model 811/902 can produce static discharges to +/-2kV for ESD susceptibility testing of devices. It can model human body, machine and charged device discharge. Readout is a 3 1/2 digit LED with a curve tracer output/ Electro-tech Systems.

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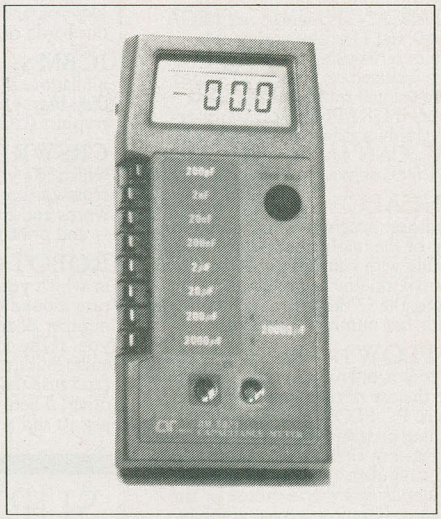

Capacitance Meter

The DM 6023 Digital Capacitance meter covers 9 capacitance ranges from 0.1pF to 20,000uF with 0.5% accuracy. Readout is a 3 1/2 digit LCD and update time is 0.5 sec. The reinforced plastic case and LSI circuitry provide reliability and durability under a wide range of operating conditions. An adjustable stand is included. KB Electronics.

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Computer-Thermometer

The Ebro CTX 1200 and CTA 1220 feature a temperature range of - 200°C to +1200°C, with fahrenheit conversion, hold, peak/valley hold, averaging, etc. The 1220 has dual channel operations, with difference readings, etc. Resolution is 0.1°C/°C; an alarm function is provided. RCC Electronics.

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DASH Audio

The DASH audio format, originated by the Sony Corporation, was proposed for worldwide tape interchange jointly with Willi Studer AG and Matsushita Electric Industries in 1982, when the first DASH multichannel recorders were introduced. In the meantime, DASH has become the dominant format for digital mulitchannel recording.

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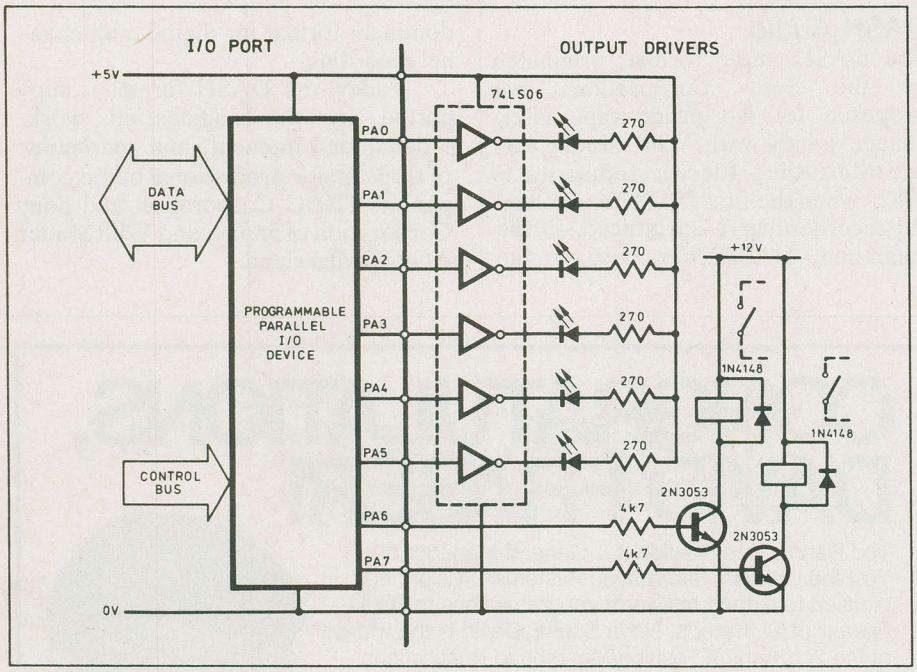


Fig. 7.11. A representative output driver arrangement.

to Port A in order to operate both relays and turn all LEDs off? Express your answer in binary.

(b) What is the hexadecimal equivalent of the value in (a)?

(c) Determine the forward current of an LED when it is operating.

(d) What should be the nominal operating voltage for the relays?

(e) Determine the collector current for the transistors in the conducting (on) state. ■

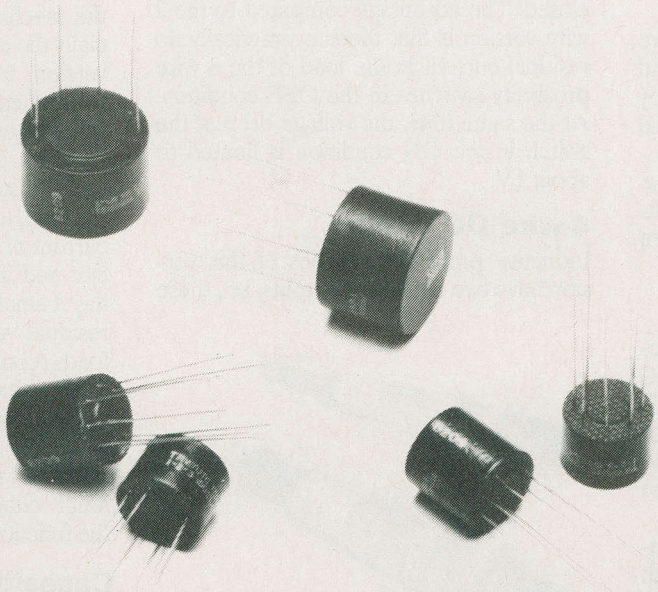
Answers to Problems

7.1 180 ohms.
7.2. 13mA.
7.3. (a) 11000000
(b) C0
(c) 11mA
(d) 12V
(e) 27mA

How Proximity Switches Work

The uses of inductive and capacitive proximity switches

DR. H. VIRANI



Automation of working processes means using machines for monitoring and control, tasks which have previously been carried out by people. These machines and installation systems need equipment which is at least partially able to replace the human eye in realizing certain processes, to replace the fingers in order to touch and to feel any changes, and to replace the abilities of the human brain and the human senses as their source of information.

When a machine takes over one of the functions of a human brain, the switch, sensor and key have to substitute for the functions of the senses. The higher the degree of automation, the greater the number of different working processes may be carried out by a machine or by a system without a human action and the more information is needed to control it.

Switches are one of the most important source of information whatever the function may be – switches that may be operated by hand, by the machine, or by the product to be manufactured.

The first function of switches was the monitoring at areas where environmental conditions meant an extraordinary stress for the operators. Therefore, especially at locations with extreme environmental factors, e.g., operation at humid locations, zones with temperatures below zero, zones with high temperatures, dirty or dusty zones etc., switches meet the special requirements.

Switch Requirements

However, mechanical switches, which had been successful for many years were no longer able to meet these requirements fully. The further development of the machines and the improved controls called for improved switches. The requirements for these new improved switches are roughly the following:

1. Unlimited quantity of switchings so that the switches have at least the same duration of life as the machine.
2. Waterproof and dust proof so that they may be used under all environmental conditions which may exist within machines and systems.
3. High switching speed so that the switches are still able to control the movements of machines and systems succeeding one another very quickly.
4. Reliable and clear execution of the switching process. Lack of contact bouncing, as the quick electric controls would take that for multiple switching, and would make a logical but false decision.
5. Low contact corrosion and low contact resistance, as the electric controls work only with very low current and control voltage.

Filling the bill

Inductive proximity switches have the following characteristics that make them particularly attractive for industrial use:

1. They're all-electronic; no parts are moved mechanically.
2. There is no wear and tear, and therefore they have the same durability as the machine itself.
3. They can be made absolutely waterproof and dustproof because there are no parts which move mechanically, so they are able to work with great reliability, even under the worst environmental factors.
4. They have, due to their solid state structure, determined constant electrical thresholds and therefore are able to actuate any electronic control without problems.

Inductive proximity switches, as a real supplement or alternative to mechanical switches, have become an indispensable switching unit of the automation industry. They are used as limit switches for the instrumentation, for automatic weighing devices, for the general mechanical engineering, and especially for conveyance plants.

In principle, an inductive proximity switch consists of a transistor oscillator and a switching amplifier. Generally, the oscillator is a series resonant circuit. When energy is supplied, the oscillator operates to generate a high-frequency field. At this moment, there must not be any conductive material in the high-frequency field.

If then a conductive material is placed in the electromagnetic field, energy is taken from the oscillator in the form of eddy current losses in conductive material. When the resonant circuit is disturbed, the oscillator is stopped. The power absorption of the whole thing will decrease. This varied energy intake is utilized by the control circuitry as a switching process. However, the consumption of energy is so small (about 16 milliwatts) that there will not be any important restoring force to the

How Proximity Switches Work

actuating element. The restoring force is less than 1 milligram and therefore is left out of account for nearly all measuring instruments.

Mechanical Versions

There are three different mechanical versions:

Slot sensors: The electromagnetic field is concentrated between two coils on a common axis. The sensor switches on when metal is placed into the airspace between the coils and actuates the oscillator.

Cylindrical and rectangular form: Here the field is arranged to be at the front end of the sensors. The sensor is influenced by the approach of metal in a radial or axial direction.

Ring type sensors: In these, the electromagnetic field is concentrated inside the ring. The sensor switches off when metal is placed inside the ring.

Electrical Versions

In principle, we have to distinguish between inductive proximity switches for DC and inductive proximity switches for AC. DC switches are divided into switches for applications in hazardous locations and switches for general applications in the general mechanical engineering.

In general this electrical version consists only of the transistor oscillator with the following functions: when there is no metal within the range of the active face the circuit oscillates. In this condition, the circuit appears as a very low resistance. With regard to a definite power source, the proximity switch has a current of more than 3mA. When the metal is placed in the electromagnetic field, the circuit appears as a relatively high resistance. The current decreases to a value of 1mA or less.

The difference in current through the circuit between oscillating and non-oscillating conditions is monitored by a trigger amplifier to give a definite switch point.

2-wire DC design

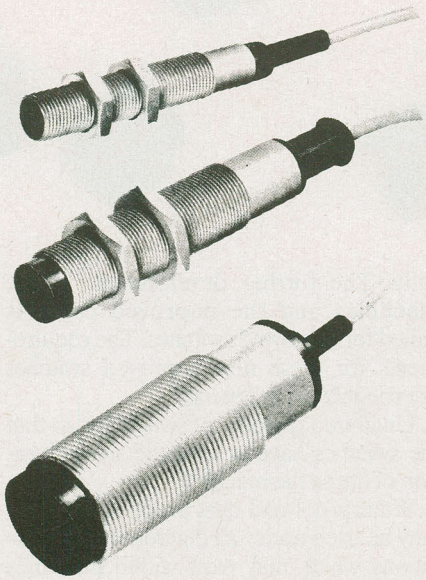
DC proximity switches in the two wire version for actuating electromagnetic relays or electronic control units are also delivered with oscillators and output amplifiers. The different versions may be compared to mechanical limit switches. For the installation, only two cores are necessary. In general, it is of no importance whether the load is connected in the positive or in the negative line. The disadvantage of this version is that these switches may only be used together with definite relays or electronic units, as the working energy for the proximity switch comes through the load and therefore, even in the ON condition, a residual voltage drop will occur.

3-wire DC design

This proximity switch consists of the oscillator as well as the output amplifier with triggering. It's then possible to operate electromagnetic relays or any electronic units without inserting between other coupling elements. Usually these switches are delivered normally-open or normally-closed. The advantage compared to the 2 wire version is that there is practically no residual current in the load of the 3 wire proximity switches in the OFF condition. At the same time, the voltage drop at the switch in the ON condition is limited to about 1V.

4-wire DC design

Inductive proximity switches of this version have two antivalent outputs, i.e., these



Inductive proximity detection sensors from Micro Switch.

outputs operate on the push-pull principle; when output 1 of a non-actuated proximity switch is in the ON condition, output 2 is in the OFF condition. If the proximity switch is actuated output 1 will be in the OFF condition and output 2 will be in the ON condition.

By the function of the two outputs the changeover contact of a mechanical switching unit has been retained. Antivalent outputs are used mainly for monitoring systems.

2-wire AC design

These proximity switches are used for actuating AC consumers like contactors, solenoid valves etc., up to a voltage of 250V. They consist of the oscillator and, in general, also of a thyristor or triac switched output voltage, permitting the direct connection to an AC mains without inserting between a coupling element. The external dimensions of these switches are almost similar to those of the habitual housings of mechanical switches.

Besides the general known advantages of the electronics compared with the mechanics, we wish to mention especially the easy monitoring due to the 2 wire version. However, apart from the above mentioned advantages, there are also disadvantages: the 2 wire version needs no separate connection for the supply voltage, the sensor is connected in series with the load, and in the OFF condition a small current of about 5mA still flows in the circuit and in the ON condition (the sensor has a small potential drop) there is still a residual voltage of 5-10V. In low voltage loads (contactors or solenoid valves with a rated voltage of 24V, 36V or 42V) there may be problems. None of these problems will occur with proximity switches for the rated voltage of 110-220V. Then the residual voltage of 5-10V has no influence on the function reliability of the contactors.

Capacitive Proximity Switches

These differ from inductive proximity switches by the kind of operation. In order to actuate inductive proximity switches, we need a conductive material. Capacitive proximity switches may be actuated by any material – wood, plastics, liquids, sugar, flour, wheat, etc. However, this advantage of the capacitive proximity switches compared with the inductive proximity switches brings some disadvantages with it. Whereas inductive proximity switches may be actuated only by a metal and are insensitive to humidity, dust, dirt, etc., the capacitive proximity switches are also actuated by any dirt in their environment.

For general applications, the capacitive proximity switches are not really an alternative, but a supplement to the inductive proximity switches. They are a supplement where there is no metal available for the actuation, e.g. for woodworking machines, for determination of silo-levels.

The mode of operation of capacitive proximity switches is also based on the principle of a transistor-oscillator. However, instead of a coil, an anode is used. The earth is cathode. When a material approaches the anode and therefore changes the capacitance of this

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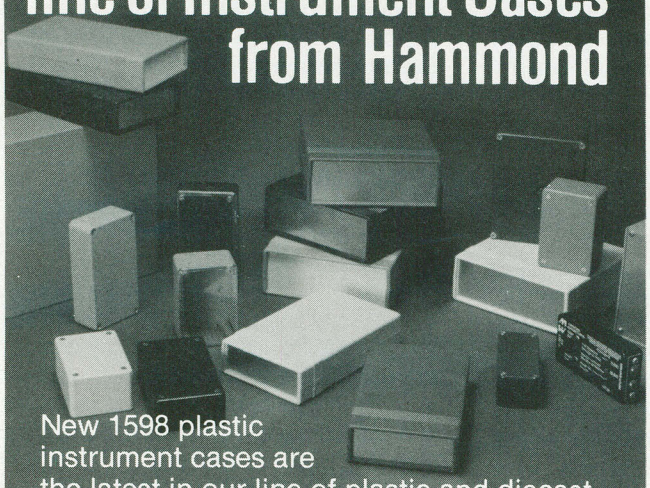

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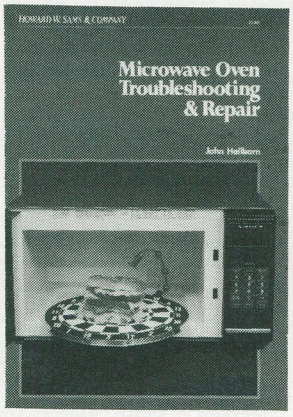

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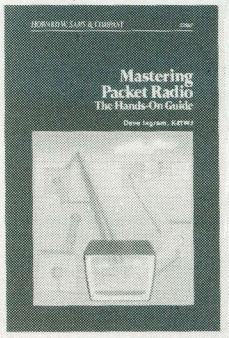

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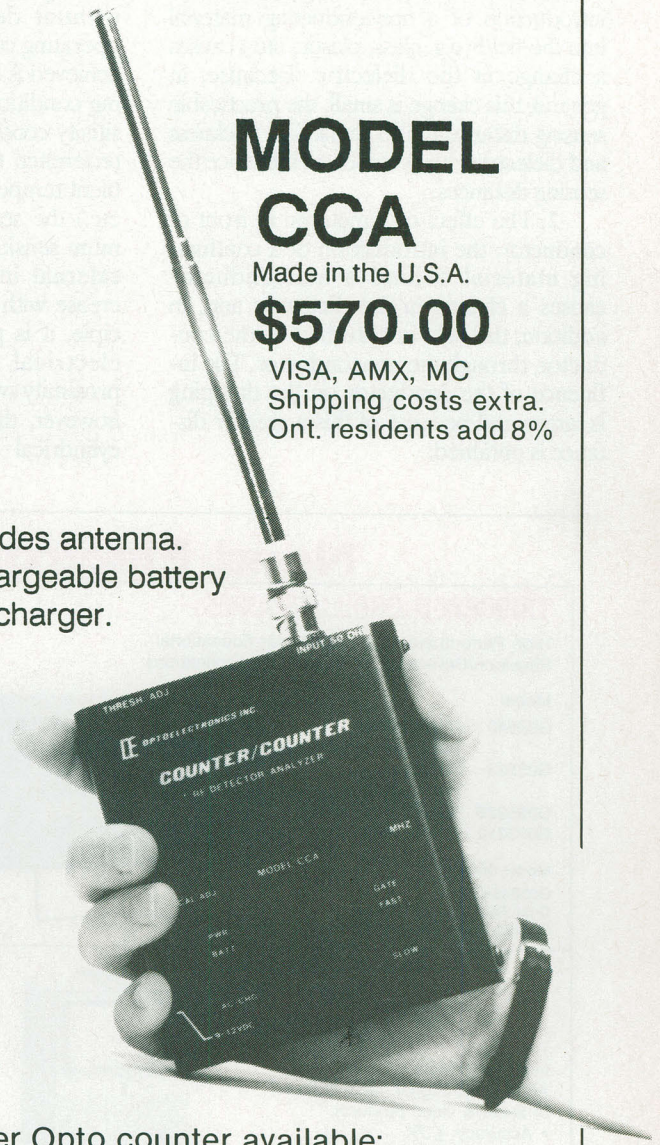

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capacitor, the originally de-tuned resonant circuit is tuned, and the oscillator starts. Again the changes in the energy intake are utilized as a switching signal.

The effect of a material on capacitive proximity switch is essentially a characteristic of its composition. There are three different ways that the effect can be used in practice.

1. The effect of nonconducting material: the introduction of a nonconducting material into the field (e.g. glass, plastic, etc.) causes a change in the dielectric. Because, in general, this change is small, the practicable sensing distance is also small. Size thickness and dielectric characteristic all influence the sensing distances.

2. The effect of a material in front of conductor: the introduction of a conducting material behind a nonconductor causes a change in the dielectric and, in addition, the field is disturbed by the conductor, through the nonconductor. The influence of the conductor on the damping is larger and because of this a greater distance is obtained.

3. The effect of a material in front of a conductor with the materials grounded: this effect is similar to those described in 1 and 2 with the addition of an absorption factor. This actual effect gives the greatest possible sensing distance. In practice, it is found that the useable effect is a mixture of the three effects described above. Therefore, it is possible to give a fixed sensing distance for capacitive sensors without detailed information on the operating conditions. The sensing distance achieved is dependent both on the operating conditions, and the setting of the sensitivity control. When there is external interference (for example, changes in ambient temperature, relative humidity, dust, etc.) the sensor cannot be used at maximum sensitivity because the effects of the external interference automatically increase with increasing sensitivity. In principle, it is possible to produce the same electrical versions of the capacitive proximity switches. Due to the application, however, they are generally produced as cylindrical or rectangular switches. The capacitive proximity switches made by Pepperl and Fuchs are available in many electrical versions:

1. Proximity sensors in 2 wire design for DC circuits for actuating relays or electronic controls.
2. Proximity sensors in 3 wire design for DC circuit containing also a trigger.
3. Proximity sensors in 4 wire design for DC circuits with 2 antivalent push-pull outputs.
4. Proximity sensors in 2 wire design for DC circuits for actuating directly contactors or solenoid valves, etc.,.

During the last 30 years, the inductive and capacitive proximity switches have been improved continuously.

Pepperl and Fuchs switches are short circuit proof and have an overload protection. They are absolutely reverse polarity protected, i.e., each line may be exchanged against one another without destroying the switch. They operate within a large voltage range, for example DC = 10-30 V, AC = 20 — 250V. They have triple protection against penetrating humidity. ■

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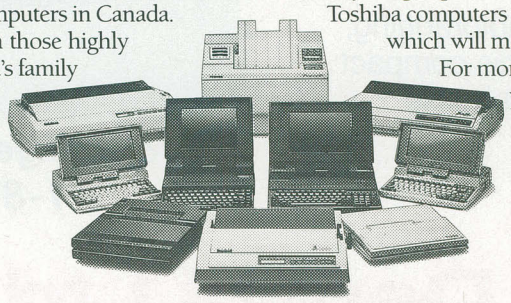

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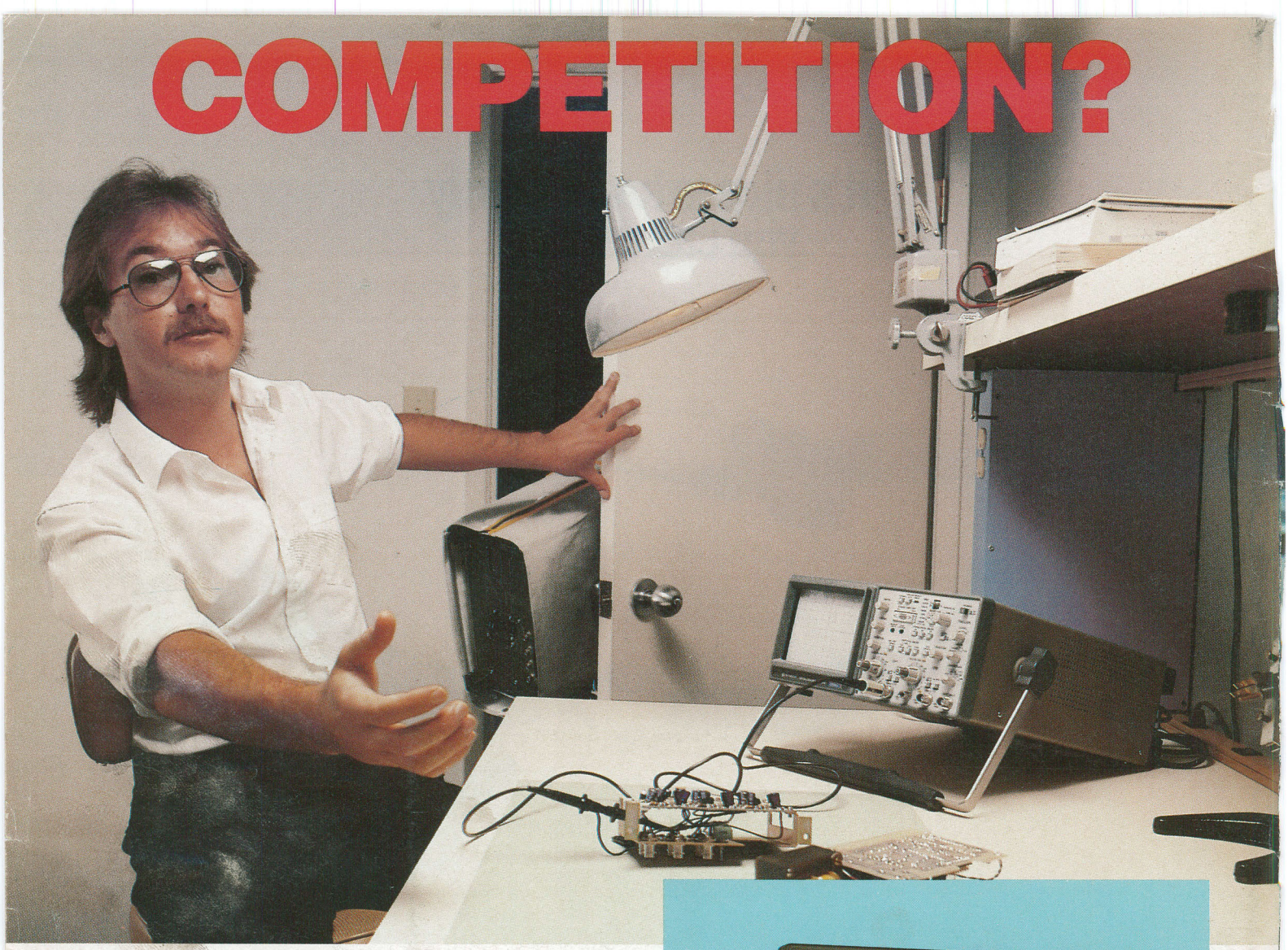

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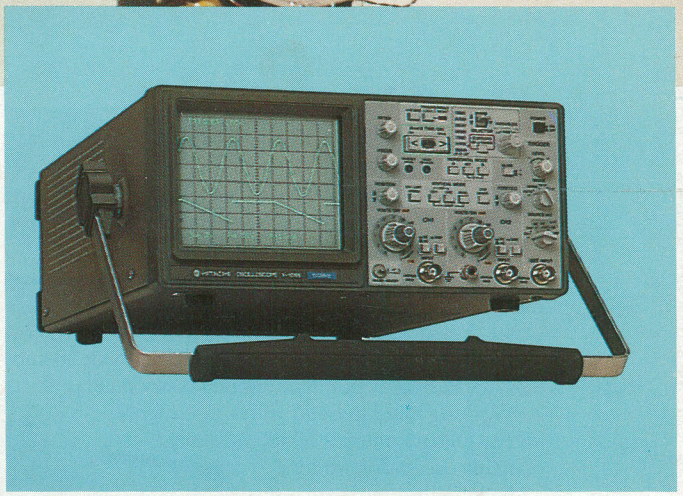

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